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BRIEFLY TOLD.

NOTES.—

IN our current item columns we report the retirement of Mr. Edwin Evans from the position of Superintendent of the gas division of the business of the Willimantic (Conn.) Gas and Electric Light Company, which place he held for many years. His retirement was caused by ill-health. We regret to have to here complete the history by reporting his death, which occurred last week, in Lynn, Mass. If we mistake not, deceased was at one time in the employment of the Hartford City (Conn.) Gas Light Company.

MR. A. M. HALLOCK, Manager of the Suffolk Gas and Electric Light Company, of Bay Shore, L. I., writing us under date of the 12th inst., says: "This Company has had more or less trouble to give good pressure of gas in East Islip, a village about 4 miles from here, for some time. The trouble would come invariably during the summer season when it is necessary for us to give higher pressure, the output being greatest then, as East Islip is quite a summer resort. Unpleasant remarks would be made about our gas service in that part of our district, but we managed to do fairly well until this summer. We have just placed 58 public gas lamps in the village and lighted them up on the 1st inst. At the time of starting them up we increased our pressure at the plant, and while we got a fair result from an illuminating point of view from the street lamps, the occupants of stores and the cottage residents complained in tones and terms louder and stronger than ever. We increased the pressure from day to day, but without avail. In fact, on the night of Saturday, August 8th, the lights in the stores were so poor that the matter became a right serious one with us. During the daytime the pressure was all that could be desired seemingly, but the putting on of extra pressure at night was the signal for renewed trouble. In an attempt to locate the seat of the trouble we took the pressure at several points along the lines, and finally spotted a sharp fall therein between two points, the limit of which was 180 feet. This was found at 9:30 P.M. the 8th inst. Early the following morning a force of men was put at the work of uncovering the main, and the usual tests enabled us to locate the drop in one length of pipe close to the hub. We tapped the main, and by means of a hook made out of stiff wire we dragged out enough caulking yarn to have caused all the trouble. Part of the yarn was fast in the lead joint at one end, and the tailing section of the yarn swung loose in the pipe, acting evidently as a flap valve when the extra pressure was put on. Now the pressure bother at East Islip is at an end, and I assure you consumers and Company are on better terms with themselves. The main was laid about 15 years ago."

THE proprietors of the St. Helena (Cal.) Gas Company have notified the residents that, until further notice, the selling rate will rule at $3 per 1,000 cubic feet, for all purposes, prompt payment (within 10 days) to entitle the user to a rebate of 10 per cent. The minimum charge for a month's use of the meter, including value of the gas consumed, is put at $1.

THE electors of Sioux City (Iowa), by a vote of 782 to 413, have sanctioned the ordinance which extends the franchise of the Sioux City Gas and Electric Company for a period of 25 years.

ARTICLES incorporating the Scio (O.) Gas Company, have been issued to Messrs. J. O. Cooper, W. J. Cook, F. J. Catlin and Jno. Calcott.

A CORRESPONDENT in San Francisco, writing under date of the 10th inst., forwards the following: "Rudolph Spreckels is virtually out of the San Francisco Gas and Electric Company. If an election were now held he could not be chosen a Director, as he has disposed of nearly all of his stock. Although the exact figures cannot be given, his illuminating experience of the last few years has been an expensive one. It has cost him what would be a fortune to many men. His holding is supposed to have been about 5,000 shares, which must have cost him around $70 a share, while the sales probably averaged $65 a share. This would be a loss of $5 a share, or $25,000, to which the loss of interest on this sum for several years must be added. The reason for Rudolph Spreckels' withdrawal is reported to have been a disagreement with his former yoke-fellow, William B. Bourn, which took place some months ago. It would surprise no one acquainted with the relations between the new powers and Bourn if he also would find it agreeable to ultimately retire from the Presidency and dispose of most of his holdings in the San Francisco Gas and Electric Company. That corporation is preparing to discontinue the generation of electricity and purchase the illuminant. It is not yet, however, decided whether the

LIBRARY OF CONGRESS. AUG 17 1903 SMITH... DEPOSIT.

electricity will be bought from the Bay Counties Power Company or from the Standard Electric Company. It is even possible that the demand may be such that contracts will have to be made with both concerns."

THE Kerr Murray Mfg. Co., of Fort Wayne, Ind., has recently completed a double-lift storage holder of 400,000 cubic feet capacity for the City Gas Company, of London, Ont.

CERTAIN residents of Marlboro, Mass., have petitioned the Board of Gas and Electric Light Commissioners to order a hearing to determine whether or not the rates charged by the Marlboro Gas Light Company are excessive.

THE Board of Public Service, of Bellefontaine, O., under whose direction the management of the local gas supply is placed, has ordered an increase in the rate charged for a fuel gas service from 50 to 75 cents per 1,000 cubic feet.

THE fifth annual convention of the International Acetylene Association was held in Chicago, last week. Headquarters were in the Stratford Hotel, and the sessions were well attended. The main topic for discussion was the hostile attitude of the fire insurance interests of the country towards the use of acetylene gas.

THE Council, of Alton, Ills., has assented to the petition of Mr. J. F. Porter, of the Alton Railway, Gas and Electric Company, for permission to extend the gas mains to and through the streets of Upper Alton.

THE Louisville (Ky.) Gas Company has decided to engage in the business of supplying natural gas for fuel purposes. The Company owns extensive gas fields in Meade county, and a pipe line between the fields and the city has been laid.

The Electric Light Industry.

Electrical World notes that early this month the United States Census Office issued a preliminary report on the figures which it compiled last year of the electric light industry in this country. These figures come in due sequence after those of the electrical manufacturing industries and the street railways, and will be succeeded by those on telephony and telegraphy. When the series is complete, at no very distant period, the public will be in possession of a body of most valuable data in regard to the new arts that have so distinguished the last 50 years, and whose exploitation has been so peculiarly a feature of American industrial advance. The great bulk of this data is, in fact, now collected for the first time, so that even here it is difficult to institute comparisons; while unfortunately hardly any country in Europe has yet begun to take statistical note in the same manner of anything but the governmental telegraphs and telephones. However, it may readily be believed that the example of the United States will be strongly stimulating in this respect, and that ultimately uniform methods will prevail for the collection of these important data throughout the civilized world, whose conditions are now being so markedly shaped by electrical influences.

The figures now published show 3,619 central station systems, with $502,000,000 invested, earning $85,145,423 a year, with expenditures of $67,688,075, inclusive of $12,501,045 interest on bonds, or exclusive of the interest, the expenditures were $55,187,030. This would show operating expenses of about 64 per cent. The figures of municipal plants are too small to disturb the general averages, but taking the private plants alone, it would appear that the $480,161,038 invested in them earns gross $78,180,318, with expenditures $50,445,848, exclusive of interest on bonds. This, it will be seen, works out at about 62 per cent. operating expenses, and shows a net of $27,734,470, or a return on bonds and stock capital invested of a little less than 6 per cent. Postponing further consideration of the other interesting data presented by the Census Office, it may here be noted that these figures do not by any means reveal the true extent of electric light and power development in America, for they do not include any isolated plants. In a city like New York there are hundreds of such plants, many of remarkable magnitude, and the country over there are probably not far from 40,000 or 50,000 of them—just how many will not be known until the next general census. It is sometimes assumed that all the isolated light and power plants equal in investment and capacity the central stations, and it is doubtless not far from the mark to say that electric light and power in this country reaches a total capitalization of $1,000,000,000, for it must also be borne in mind that thousands of buildings now have a supply of current where the cost of installation has been met entirely by the customer, who has no plant of his own, and depends upon the local central station.

Address of the President (Mr. M. C. Osborn) of the Pacific Coast Gas Association on the Occasion of Its Eleventh Annual Meeting, San Francisco, July 21-23.

Members of the Pacific Coast Gas Association—Gentlemen: Another year has elapsed since we assembled to discuss the conditions confronting our business and exchange our experiences for the year.

Our Association, taking in the States of California, Nevada, Oregon, Washington, Arizona and Utah, and including British Columbia, no doubt has more natural resources for the production of artificial light in its many forms than any of our sister States embraced by the several Gas Associations east of the Rocky Mountains. Bordering on the north we have our vast coal deposits with water power in abundance, while in the east we have our coal. In the west and south we have a natural storage of oil easy of access, the extent of which is beyond the calculation of man, with the ever-flowing streams of our mountains to furnish light and power. Taking into consideration the few years the Pacific Coast has been inhabited by civilized man there can be no doubt but that these resources are as well if not better developed than those of the States east of the Rocky Mountains, or of Europe.

The climatic conditions enjoyed by the Pacific Coast States make the introduction of light and power to the centers of population comparatively easy with reference to the conditions in our sister States; so it is not to be wondered at that in some of our operations we challenge the world.

Since our last meeting vast combinations in the lighting industry have taken place, which affect the personal, mechanical, commercial and social relations of the companies and members embraced in this Association.

Before entering upon the discussion of the subjects of live interest, it becomes my sad duty to inform you of the death of one of our members, Mr. C. E. Burrows, Jr., who was accidentally drowned in Puget Sound, August 9th, 1902. The death of Brother Burrows is particularly sad, coming as it did during a promised vacation after the return of C. E. Burrows, Sr., from the last meeting of this Association as its President. Very little is known as to the actual cause of the accident. It happened on a pleasure yacht in Puget Sound. All had retired to their staterooms for the night in the best of spirits. In the morning Mr. Burrows was not to be found. The body was recovered the same day. It was marked with a cut over the right eye. It is supposed that he fell overboard. His last words to his host were: "This is the best week I have ever spent in my life." While Mr. Burrows had never attended a meeting of the Association, he had been identified with the lighting business all his life, and it was his intention to attend this meeting and associate with its members as his honored father has. It was the intention of Mr. Burrows, Sr., to soon retire from the active management of the Walla Walla Lighting Company and install his son as a worthy successor. Brother Burrows was 31 years of age and leaves a father, wife, son, brothers and sisters to mourn his loss. It will be the duty of the Association to pass suitable resolutions expressing our sympathy and condolence to the bereaved relatives.

Perhaps the most startling discovery made in the scientific world affecting the lighting industry is a new metal called "radium," which is manufactured from a radio-active mineral called pitchblende. It requires 5,000 tons for 1 pound of radium, and is practically indestructible. It is reported to give light, heat and power, but it is still in its experimental stage so that nothing is known of its practicability. It is possible, however, that the energy we are collecting from our mountains and the gas from our coal and oil will yet be a factor in the production of this wonderful mineral.

It has been said that the receipts of a lighting company are a better barometer of the times than any other business. The lighting business, like all other industries, has enjoyed a year of unparalleled prosperity. This is so much the case that enlarged capital has entered the field, in some places rates being increased, in others reduced, the service improved and capital guaranteed a fair return on its investment, so that it can safely be said that the lighting question on the Pacific Coast is now on a more satisfactory basis, both from the point of view of the owner and consumer, than ever before in its history.

The social relations formed by the meetings of this Association have assisted in this encouragement of capital so that the men at the helm and the men of capital are more closely united than ever before. The men who organized this Association were at the time of the organization hampered by a lack of concentrated effort. The association of capital has brought them together, so that there is a unity of action with all working for the one common purpose of manufacturing and selling our commodity at the lowest price consistent with its cost, and

which cost has been materially reduced by reason of this association of capital. To verify the foregoing, I wish to call to your attention the facts gathered in answer to my circular letter of last April. The record is not so complete as I would like it, only 26 companies having responded. These reports show that the first works were built in 1858, and the last in 1902. The highest price per 1,000 at date of erection was $10, the lowest 52 cents per 1,000, the average for the 26 companies being $5.16 per 1,000. The highest price to-day is $3 per 1,000 and the lowest 52 cents, the average being $1.52 per 1,000. Two other factors, however, enter into the development of our industry; namely, competition and oil. The advent of electricity, generated as it was from central stations, proved to be an educator to managers of gas companies, so that when the energies generated in our mountains were transmitted by conductors to our doors we were prepared to treat them as a friend rather than a competitor. The result is that to-day gas and electricity go hand-in-hand, and we are no longer gas engineers and gas men but, as Past-President Britton remarked in his address 2 years ago, we are engineers of lighting and men in the lighting business. For reasons known to us all, electricity is fast gaining the ascendency for lighting purposes, so that the men in the lighting business are devising new avenues for the sale of gas in the shape of fuel and power. Such enormous strides in this direction have been taken that it is safe to say more gas is being sold to-day than would have been had electricity not become practicable for lighting purposes. The competition of solid fuel against fuel gas has brought out more engineering skill and business energy from members of our fraternity than any other event in the history of lighting and fuel on this Coast.

Improved apparatus reducing the cost of production, large extensions of our distributing systems, tending to increase our output, intelligent business management presenting our commodity to the public in a proper manner, are a few of the many things that have brought the gas industry to the prosperous condition it occupies to-day.

The discovery of oil within easy reach is the other factor which has enabled us to successfully compete with solid fuels. It is useless for me at this time to dwell on the importance of this commodity. Its commercial and industrial value will be brought out later in the session.

Municipal ownership is still being agitated in some sections, and in this connection I will give some data coming from properties owing their existence to gas and electric light commissions, and which have particular significance with reference to the agitation in favor of gas and electric light commissions on this Coast. The Board of Gas and Electric Light Commissioners of the State of Massachusetts exercises the control of capitalization and the rates for gas and electricity in that State, and governs the granting of franchises, guaranteeing existing companies returns on the capital invested. Public ownership controls 3 gas and 15 electric plants. The average price of gas in these plants is 48 cents per 1,000 higher than the average price of gas on which I have reports on this Coast. The average cost of electric street arc lighting is $75.60 on a moonlight schedule, and for all-night lighting $137.73 per lamp per year, while the charges for current range from 10 cents to 25 cents. From reports received from the two gas plants operating under public ownership on this Coast I find that one charges 23 cents and the other 98 cents per 1,000 more than the average price of the private companies. With reference to one of these plants, its town is bonded for the purchase of the gas property, the same to be paid for by the profits from the sales of gas, thus compelling those who are in the minority, to wit, the gas consumers, to pay for the public utility, being an apt illustration of the defects in the theory of municipal ownership.

I wish to emphasize the words of Past-President Britton, who said two years ago: "There is one safe and sure remedy that can be applied to cities where it does not exist as a preventive, and that is the placing of all corporations on a footing where criticism cannot be made of their methods of earning interest on the moneys invested." It is interesting to note that the policy is being carried out. Public ownership is still being agitated when it is a fact well known that the prices at present charged by local companies are lower than the cost of production would be to the municipalities which are agitating public ownership.

The labor question has affected our industry in some sections as it has other industrial pursuits. In my judgment, the situation depends upon the old law of supply and demand. So long as the demand for labor remains greater than the supply, labor will demand and receive a hearing in turning the wheels of our industry.

Like my predecessors, I have to report that the prepayment meter has not met with the favor on this Coast it has received in the Eastern States and in Europe. This would indicate that this meter is more adapted to larger centers of population. As far as my personal observation goes I have in mind a plant which had a larger proportion of prepayment meters in use than any other and the smallest consumption per meter than any other plant that has come under my notice.

The question as to what is considered good business policy in the introduction of gas consuming appliances seems to have been settled by common consent, the custom being now general to install at cost.

The policy of having two meters, one for light and the other for fuel, is still a mooted question, and in my judgment will only be settled when we have reached that point in increased consumption when the cost of distribution will be so nearly alike that the difference will not pay for the additional installation.

All questions submitted to the Advisory Board have been promptly answered, and it is to be hoped that it will be more generally consulted as time goes on. The Board was created by the Association for the purpose of lending assistance to all who might require it.

A question of great importance to my mind, and one of deep interest to those who are brought in close contact with Association matters, is the library. The Library Committee is to be commended for its energy and for its judgment displayed in the selection of some 180 volumes in addition to Gas Association Reports, bound JOURNALS and matters of general interest to our Association. The collection has been made within the last 2 years and is made up entirely of donations. The publication of the Library Catalogue last March has stimulated interest in the library, but it has not reached the point of usefulness to the members in general that it should attain, as there are no funds available. Various ideas have been advanced to promote this very important matter. The most feasible one seems to be the proposition of establishing headquarters for the Association with a librarian in charge. To promote this idea and assist our Treasurer, you will be called upon to vote on an amendment to the constitution and by-laws to establish Association memberships. The condition of our treasury shows that, as the membership now stands, all money received is absorbed to pay our fixed charges, leaving nothing for the library. It is doubtful if the plans thus far advanced will raise a sufficient amount to enable us to carry out our cherished idea.

At our fifth annual meeting a resolution was introduced proposing to change our name and to form this body into a gas and electric light association. The resolution was promptly voted down. This was at a time when gas as an illuminant was being displaced by electricity. Gas as fuel was in its infancy. A majority of our members were gas men, with electricity as a competing power, and a certain amount of friction existed. Time has worked great changes in the personnel of this Association. As has been said, we are no longer gas engineers and gas men but engineers of lighting and men in the lighting business. Very few remain who are still competing with electricity, but on the contrary nearly all are selling it. For several years back we have had papers read at our meetings dealing exclusively with our ancient enemy. We now have prices so adjusted that gas is a strong competitor in the lighting field, and its use as a fuel is established beyond question. It has a future in the industries of the world both as a necessary commodity and as a money maker. It may be said that if a change were made the electrical interests would crowd the gas men out. The fight that we as gas men have put up for several years would tend to disprove this theory. We are all primarily gas men, and I believe that if we should change to a gas and electric association, that the gas interests would receive all the prominence in our proceedings that their position in this industrial world and its relative commercial value with what might be termed its brother illuminant, would deserve. As an Association we would become broader and would expand our sphere of usefulness by the change, and be another source of revenue.

I will not consume your time by giving a resume of the papers prepared for this meeting, except to say that they are all on live topics of interest to gas men, and as far as possible the wishes of the members in answer to my circular letter have been carried out in their preparation.

High Pressure Gas Distribution.[1]

By MR. JOHN A. BRITTON.

When asked to prepare a paper on high pressure gas distribution I complied, after very considerable urging, fully realizing, as results have proved, the utter futility of attempting to properly express in a paper, that would be short enough to be interesting, any considerable portion of the data requisite to make the paper understandable. It is truly a subject of vast proportions, and of such magnitude not to be lightly treated or summarily dismissed; its ramifications into lines other than those ordinarily dealt with in low pressure gas distribution will admit

1. Read at the 11th annual meeting, Pacific Coast Gas Association, San Francisco, July 21-23.

of volumes being written. The question of what to eliminate from my effort has been a harder one to decide than the mere writing of it. After mature deliberation I have written on the subject entirely from the practical side, omitting all technical details or dissertations, so that the subject may be freely and fully discussed in its bearing on the every-day work of the "man behind the gun."

Much has been written on the subject of flow of gases through pipes at different velocities, so that whatever I might write would be but a poor repetition; suffice it then to say that the variation of density with variation of pressure, due to the elasticity of gases, makes the determination of the friction losses a most complicated matter. The variation in velocity of flow throughout the length of the lines results in a variation in frictional resistance, and the loss of pressure in a unit distance is never the same at two points in the pipe.

The economical point of horse power required in gas compression is a large factor in determining the utility installation, and in large plants designed for high pressure alone, this should be carefully considered.

The only science that has not kept pace with the developments of the last century, and that has not taken advantage of the suggestions of allied sciences to improve and enlarge its scope of usefulness, is the science of the manufacture and distribution of artificial gases. While the sciences of electricity, telegraphy, mechanical and civil engineering, and telephony, have moved with gigantic strides over the face of the earth, the improvements in the domain of gas science have been few and far between. From the destructive distillation of coal in retorts externally heated, either by open furnaces or by the many types of regenerative, to the process of carbureted water gas, was a far cry, and to crude oil water gas still another, while in the mechanical and other devices covering manufacture and distribution few of any importance have been introduced in modification or improvement over those in use 40 years ago; the perfection of the use of oxide of iron in place of lime for purification and the inclined retort standing out strongly in relief.

This condition of apathy may perhaps have been due to conditions of supply and demand, but the fact presents itself that, until gas found a strong competitor, no especial progress was made for the improvement, either of the apparatus in manufacture or in the means of distribution. New processes made possible by the discovery of oil in Pennsylvania, in 1875, were derided, frowned upon and condemned; but finally, against the greatest of odds, these found their way into service. Those who came to scoff remained to pray, and the use of carbureted water gas, under the patents of T. S. C. Lowe, has become universal.

In those good old days when "Gas was King," the engineer applied his time within his laboratory in attempting to discover new phases in the composition of his gases, and worked hard and long to extract from the pound of oil or coal the greatest amount of salable gas, at the minimum cost of labor, but when the gas left the outlet of the holder it was, like a poor orphan, turned out to shift for itself. Skill and science cared for it no more, and the complaint man, with pliers and tongs, was the only friend it had. Leaky mains and defective meters were tolerated so long as the price could be maintained and the manufacturing results show well on paper.

In 1884 electricity infused new life into the *dolce far niente* existence of the old time gas man. He woke one morning from his dream of peace, to find an active, strenuous little fellow in his field, whose sole ambition was to get next to the people, to show them the value of his article, and to point out its many uses. He buzzed and fumed all day, and dreamed of new schemes at night; was never satisfied with what he had done yesterday, but was determined to do a little better to-day; and, what is more, he did so. Then "Rip Van Winkle Gas" arose irom his mighty sleep, adjusted his spectacles, rubbed his eyes, ejaculated "God bless me," unbent the rusty hinges of his gas anatomy, and went valiantly to work. He found new uses for his product, awakened the interest of the public and of inventors, increased his output, gave as much and more attention to the sale of the product than he gave to its manufacture, and has proven himself not only a keen rival to electricity, but in many respects its master. The two have become fast friends and are lying down together as the scriptural lion and the lamb.

To the timidity of the profession may be attributed the fact that even to-day high pressure gas distribution has not found favor with gas engineers, or it may be perhaps due to the old time disease of being willing to let well enough alone; for of a certainty the advances made in that departure from old time customs have been long enough in use to demonstrate without a doubt the entire feasibility of the plan. Natural gas has been transmitted and distributed for years over large areas of territory, at pressures greater than are carried in modern types of steam boilers, and now that gas appliances may be obtained for high pressure, there is no good reason why it should not be adopted whenever and wherever the occasion requires, if the engineer will cremate his old time hobby of leakage, and look for leakage where it generally belongs (and that is in the generating room) and not bolster up his manufacturing results at the expense of his distributing system.

The purpose of this paper, which I promise you will be brief, will be to show how high pressure can be utilized. First, to save the laying of expensive mains; second, to bolster up low pressure in outlying districts; third, to transmit gas from district to district, using the high pressure mains as step-down transformers.

I shall not touch upon the question of high pressure gas transmission, except as an incident leading up to the main question of distribution. High pressure gas transmission has been known for many years and in practice with never failing results. In this connection the experience of the Oakland Gas, Light and Heat Company may not be without interest.

In 1885 it was desired to force gas from the station of the Company, in Oakland, at the corner of First and Washington streets, to a holder in the city of Alameda, a distance by shortest route of 8,300 feet, across the estuary of San Antonio (a salt water creek), and discharge about 4,000 cubic feet per hour into the holder, the method used for 5 years previously having been the exhaustion of gas at the holder from the mains laid from Oakland. The crossing of the estuary involved laying a submerged pipe 2½ inches in diameter, 265 feet long, to a depth of 28 feet below high water, the pipe used for the rest of the distance, from the pump to the estuary and from the estuary to the holder being 4 inches. The pump used was a type of rotary made by Wm. Foster, of Brooklyn, N. Y., similar to what has been used for pumping tar at the gas works. It had 8-inch connection and was 16 inches by 16 inches, making 90 revolutions per minute, and belt-driven from a 5-horse power steam engine. The following excerpt from the diary of Mr. Van Leer Eastland, Superintendent at that time, gives these interesting details:

"The work was completed on the 28th of August, 1885, on which day the submerged pipe was lowered to the bottom of the creek on the line of Webster street drawbridge, commencing from the northern line of draw, thence running at an angle easterly to get around pier of draw of drawbridge, thence westerly to the southern end of draw. The pipe was 2½ inches wrought, ordinary gas pipe in thickness. This was first painted with coal tar while the pipe was hot. It was then served with strips of cotton cloth that had first been saturated with coal tar, and wrapped so as to make the covering of cloth lap, and this again painted with asphaltum and coal tar. The joints were run together with sockets over which were placed cast iron sleeves 8 inches long, run with a solid joint of lead, and then treated in the same manner as the pipe. When completed the compressor, at 90 revolutions per minute and 10 pounds initial pressure, delivered at the holder 3,200 cubic feet per hour; pressure at holder, 2 inches."

This pipe remained in service over 8 years and was never renewed, excepting in cases where schooners going through the draw would drag their anchors and pull up the pipe. Such an emergency was provided for by pipe running over the draw and connected to the main line by flexible joints and having a valve at either end.

In 1893 this route was abandoned, and an 8-inch cast iron pipe laid through East Oakland across the estuary at its eastern point, a distance of over 7 miles; the gas being pumped by an exhauster (or pressure blower) having a capacity of 500 cubic feet per miuute at 3 pounds. The pipe was laid under the bottom of the creek in a concrete tube, this being made possible owing to the Government engineers shutting off the water from that point during their construction of rest piers for a drawbridge.

It may be mentioned here that at no time has the candle power of the gas delivered in Alameda been lower than the recorded candle power in Oakland, and it has been noticeable that at no time in the past 18 years has a complaint ever been received from the Alameda district of naphthaline, nor have the drips in the 27 miles of street mains in that city ever required pumping more than once in 2 or 3 years while the drips on the main pumping line require little or no attention, except where located on the line crossing over a waterway, the pipe being exposed at that point for about 1,000 feet to the action of the elements.

This latter line has been operated at an initial pressure at the station of not to exceed 5 pounds, and at that pressure delivers 50,000 cubic feet per hour into the holder, and at 3 pounds initial pressure, delivering 30,000 cubic feet per hour. The type of exhauster is that of the P. H. & F. M. Roots Co.'s make, with a capacity of 350 cubic feet per minute, with 1 pound initial pressure. Pressure at holder, 6 inches at outlet.

This line running through East Oakland gave rise to the first experiments of the writer with high pressure gas distribution—that section of the city, in 1897, developed a largely increased consumption. The main feeders were too small too meet the demand, and the pressure in the winter of 1896 had fallen, in the extreme portions of that district, to as low as $\frac{6}{10}$ inch. Plans were made to increase the size of the mains from the works, a distance of over 2 miles, at a cost of $12,000 to meet this demand, and to obviate this large outlay the writer conceived the idea of making the high pressure line a feeder to this district, and immediately took up the matter with Mr. S. F. Hayward, of the Connelly Iron Sponge and Governor Company, and after quite a lengthy correspondence, and a personal visit to New York, the Connelly people undertook the building of a balance governor to fit the requirements; one that would operate at 10 pounds on the inlet and distribute at 4 inches on the outlet. This governor was installed in July, 1897, and has been in constant service ever since. It has never failed, operating as well with 3 inches on the inlet as it does with 10 pounds, which it is sometimes called upon to take care of. The result of this boost of pressure saved $11,000, and has taken care of the increased consumption in that district during the past 6 years, which amounts to an increase of 300 per cent., besides feeding back through the main lines to Oakland proper, taking care of a district having 40 miles of mains with a daily consumption of 200,000 cubic feet, and serving 1,800 consumers. Nowhere along these lines has the pressure ever fallen below 3 inches The largest main in the district is 8-inch, while the majority would not exceed 4 inches. The exhauster is run only during the time of peak loads, say for 3 hours each night (except when filling holder in Alameda), and the initial pressure at that time is rarely over 2 pounds. Connections to the governor are 8-inch, and the governor is located at or near the center of the greatest demand in the district supplied.

There is another high pressure station upon this line, situated in the City of Alameda, operating under conditions similar to the one in East Oakland, which boosts the pressure in the eastern part of that city, the district being too far away from the holder to receive the benefit of its working pressure on account of small mains. There is also another station from this line in the easternmost portion of Oakland city, where a tap of 1-inch pipe connected from the pumping line gives volume and pressure sufficient to fully supply consumers 3 miles away, on a 4-inch line, the consumers numbering 120, the size of pipes into which the gas is forced being 4 inches.

The foregoing is merely descriptive of a condition where a transmission line is made effective for building up a low pressure district during hours of greatest consumption.

Direct high pressure distribution presents difficulties which do not appertain to the system just described, but none that cannot easily be overcome, yet it is justified only where low pressure is not obtainable along the lines heretofore set forth. For direct high pressure, straight line compressors, either direct or belt-driven, may be used, and a pressure employed necessary for the size and length of mains to be laid. Where pressure of under 15 pounds is employed a preferable installation would be a positive blower, on account of minimum expenditure of horse power per 1,000. The direct high pressure system can be operated at from 1 pound to 100, but extreme care should be used in the laying of pipe. Wrought iron should be used where pressure above 10 pounds is employed and individual governors placed upon such service. The Oakland Company has a line of direct high pressure in operation, being a main line running from Oakland to Berkeley, a distance of 7 miles, along which line are consumers. An initial pressure at peak conditions of 2½ pounds diminishes 3 miles from the station to 9 inches. The services on the first 3 miles are served by individual governors, and for the last 4 miles tin meters without governors are used. This line is all cast iron, and from 3 inches to 6 inches in diameter. Pumping is required all day and until 9 P.M. at varying pressure, from 15-inch water pressure to 2 pounds, depending upon load, the holder pressure of 6 inches at Oakland serving for the balance of the 24 hours. The end of the line is connected into the low pressure system of Berkeley, which is tied into the low pressure system of Oakland. The high pressure and low pressure at Berkeley consist of 30 miles of mains, and serve 3,000 consumers with a daily consumption of about 200,000 cubic feet. No difficulty has been experienced in this service, either as to quality or quantity of gas supplied, and the same observations made, concerning freedom from stoppage on the first line, apply with equal force to this one.

The inlet and outlet pipes to and from the exhauster or compressor should be large enough in area to contain enough gas to prevent a vacuum in the inlet, pressure being always desirable, and that as near as possible to the pressure of the holder from which the gas is drawn, and the area of the outlet should be large enough to prevent the pulsations which will follow from confining the gas under pressure in a small space near the compressor. These can be easily provided for, our custom having been, where 8-inch connections were made to the exhauster, to have the inlet and outlet of 20-inch pipe, for a distance commensurate with the supply and demand. There should be no dead ends to a high pressure line for obvious reasons. Compression tanks should be used for the purpose of a steadiness of supply and as a reserve. These may be filled at extremes of pressure, and the service to the mains graduated in pressure as the demands require by suitable governors. Recording charts are indispensable at different points along the line for determining the pressure, and may be used with an electrical connection to the motor driving the exhauster for the governing of speed to meet conditions.

I will now briefly illustrate with maps the possibilities of high pressure, leaving the matter of the installation of plant, laying of pipe, types of meters and governors for a future paper.

1. As the only means of supply.
2. As an auxiliary means of building up districts of low pressure.
3. Used for both of above purposes.
4. In transmission of gas from one storage plant to another.

(On maps, *A* indicates high pressure lines, and *B* low pressure.)

Under the first head, given a certain district to be supplied with either a known or assumed consumption, the first determination necessary is the carrying capacity of mains under given head, with due allowance being made for friction; second, the installation of steam or electric driven compressors or exhausters, depending upon pressure desired, and these should be in duplicate; third, compression tanks; fourth, individual governors.

Assuming a daily output of, say, 80,000 cubic feet, with a peak load delivery of 15,000 feet per hour, an ideal installation would be a compressor having a capacity operated under 70 pounds of a delivery of gas into compression tanks, holding 30,000 cubic feet. These tanks could be built in series, superimposed. With suitable governors the discharge could be graduated to deliver upon mains at any desired pressure, and the tanks could be filled during hours of peak conditions, and would then contain sufficient gas to obviate the necessity of constant use of compressor.

Under the second head, the high pressure mains may be laid to a point in the system where previous takings of pressure have indicated lowest point of good service at maximum hour of demand, and at that point a governor of sufficient capacity to give a normal pressure during the maximum hours should be installed. This method renders necessary the operation of the plant only during peak conditions, where pipes of the distributing system are of a normal size, and affords ample time for all necessary repairs. In small districts, having but one connection to high pressure line and desiring or needing additional pressure, no governor will be necessary, as a tap of small pipe connecting both systems will afford all of the gas required, and sensibly and efficiently build up pressure to any desired point, as well as carry the volume desired, all of this being predicated upon the fact that the low pressure district was originally piped for low pressure.

Third, assuming a district already piped under low pressure, with a growth in outside limits impossible of service from holder pressure and existing main lines, a high pressure loop may be run, for connection into the low pressure system by means of district governors at certain desired points, and for further extensions along the line of demand under high pressure. All of the consumers on the high pressure line should be equipped with individual governors. This plan obviously requires the operation of the plant during the entire 24 hours of the day, and, therefore, there should be a duplicate set of compressors for safety, and also the installation of compression tanks.

The fourth condition is old and needs no detailed explanation. All of the conditions herein described are in actual and successful use in the State of California.

Much stress has been laid by the opponents of high pressure upon the extreme danger to life and property by its use. This may be answered by the statement that, in six years' use of high pressure by the writer, varying from 1 pound to 10 pounds, introduced into over 3,500 houses, no accident has so far occurred, and there are members of the Association present to-day who will testify that the tapping of a high pressure main is attended with less danger than the tapping of a low pressure one, for the simple reason that the pressure of the escaping gas draws more air into the hole, and dissipates from its own pressure more rapidly the gas into the atmosphere, preventing, especially in gases of low specific gravity, the accumulation which makes the danger.

In connection with high pressure, I venture to give an experience in Oakland in the matter of gas supply to a building, where the demands

of the architect called for a 3-inch connection. At an ordinary pressure of, say, 3 inches, this would have been inadequate. The dwelling being upon the line of a high pressure main, I insisted that the size was unnecessary, and finally, after guaranteeing the owner against any lack of supply, was permitted to make an inch tap, which gave more gas than they could possibly use.

High pressure gas distribution has come to stay, and the writer prophesies that, taking into consideration the low cost of a distributing plant, and the freedom from the ills that the gas flesh is heir to under present conditions of low pressure supply, which are eliminated by high pressure, that the day is not far distant when it will take that place in the gas world where it deservedly belongs.

Wrought Pipe.[1]

By Mr. Franklin Riffle.

The age of steel is pre-eminently one of industrial economy. All methods of manufacture and operation are measured by the standard of efficiency. Any proposed system that can prove its ability materially to increase the efficiency of a dollar, or a day's labor, or a pound of coal, is sure to receive prompt recognition. Taking the gas industry as an example, no sooner was it shown that, by the adoption of new methods, the same volume of gas could be economically transmitted through a small pipe as through a large one under the old system, than a number of pipe lines were projected for the transmission of gas in communities where pipe lines of larger diameters would be unprofitable.

Transmission of gas under high pressures is but the logical result of the successful application of high pressure methods in the transmission of water, steam and air. High pressures for natural gas have been used for nearly, or quite, a quarter of a century, while it is barely 3 years since the first important high pressure pipe line was laid for transmitting artificial gas. But these 3 years have wrought wonders, and during this brief period the new method has developed from the experimental stage into an established system.

As with high pressures for water, steam and air, wrought steel pipe, because of its high tensile strength, and its reliability, even when subjected to sudden shocks or abnormal stresses, whether from within or without, has been universally adopted for high pressure gas pipe lines. This class of pipe, therefore, is now, more than ever before, attracting the attention of gas engineers, just as in the past it engaged the attention of hydraulic and mechanical engineers, when they were called upon to deal with higher pressures than were found practicable for cast iron pipe.

Manufacture.—The development of the wrought pipe industry forms one of the great industrial achievements of the nineteenth century. It had its beginning about 100 years ago, when the introduction of illuminating gas in England created a demand for pipe, which was promptly met by the manufacturers of gun barrels. The close of the long wars between England and France left on the hands of manufacturers large stocks of this commodity. These were converted into gas pipes by threading the large ends on the inside, and the small ends on the outside. They were easily connected by screwing the small end of one tube into the large end of another.

The gas pipes of 100 years ago were lapwelded by hand over a bar or mandrel. The process was slow and laborious. The several steps were as follows: 1. Preparing a strip of iron of the required width, thickness and length. 2. Scarfing the longitudinal edges. 3. Heating to the proper temperature for bending. 4. Bending or rounding over a mandrel until the scarfed edges lapped. 5. Heating in a forge, a few inches at a time, to a welding temperature. 6. Slipping over a bar, and then hammering the lapping edges until welded.

The last two operations had to be repeated many times before the tube was completed.

The first decided advance in the manufacture of gas pipe was made in 1825, when James Russell, a manufacturer of gas tubes and gun barrels, discovered that a satisfactory weld could be made by butting and squeezing together the edges of a properly rounded and heated strip of iron. This was accomplished by means of a pair of semi-circular dies, slightly smaller in circumference than the width of the metal. As in the lapweld process, the buttwelded tube was made by alternately heating and welding a few inches at a time.

Coincident with the invention of the buttweld process of making pipe, Mr. Russell introduced the screw socket or coupling. This was an important step in the evolution of wrought pipe, since it permitted the sections to be made of uniform diameter from end to end.

1. Read at the 11th annual meeting, Pacific Coast Gas Association, San Francisco, July 21-23.

John Russell's method of buttwelding pipe was short-lived. It was soon supplanted by an improved process which consisted of drawing the prepared strip of metal, properly heated, through a circular die, thus welding the entire tube at one operation. This is the method of manufacturing buttwelded pipe at the present day, although, of course, many economic improvements have been made since its introduction 75 years ago. The buttweld process involves the following operations:

1. Clipping the corners of one end of a strip of metal, previously rolled to the required dimensions.
2. Heating to a welding temperature in the welding furnace.
3. Seizing the clipped end and drawing from the furnace with a pair of tongs, over which the operator throws a die or "bell," which drops into the bell holder; then connecting the handle of the tongs, by means of a "hook" of special design, to a link of a moving chain which draws the strip through the "bell," thus welding it into pipe.
4. Delivering to a moving table, on which the pipe partially cools.
5. Feeding into sizing rolls, which shape and size to the required diameter.
6. Passing through straightening rolls.
7. Delivering to a slow-motion shifting rack, and cooling.
8. Cutting off the ragged ends, and threading.
9. Screwing on couplings.
10. Testing by hydrostatic pressure.

With the development of steam engineering during the second quarter of the 19th century, came a demand for pipe of greater strength than the buttwelded pipe of that period. As the hand method of lapwelding was slow and expensive, the feasibility of making lapwelded pipe by machinery naturally occupied the attention of the more progressive pipe manufacturers. After a long period of experimenting, Messrs. Russell had the satisfaction of putting in successful operation, in 1835, the process of lapwelding which (although somewhat modified and much improved) is used by the pipe mills of the present day. The operations are briefly as follows:

1. Beveling the edges of a strip of metal of the required dimensions.
2. Charging into the bending furnace.
3. Drawing from the furnace at a red heat through a die and over a mandrel, thus rounding the metal and overlapping the edges. For pipes of large diameters it is necessary to use bending rolls, similar to those used in boiler shops.
4. Charging into the welding furnace.
5. Pushing from the furnace by means of a long rod, termed the "pushbar," into the welding rolls. These rolls are grooved to correspond with the outside diameter of the pipe. A projectile-shaped mandrel, held in position by a long bar, corresponds with the inside diameter of the pipe. As the pipe is drawn over the mandrel the rolls exert sufficient pressure on the laps to weld them. Each pipe as fast as welded is quickly disengaged by withdrawing the bar from the mandrel.

The finishing operations are the same as in the buttweld process.

The great essential in the manufacture of welded pipe is a properly designed welding furnace, in which the skelp can be brought to a uniform welding temperature throughout its entire length. Next in importance is the personal factor. It is one man's business to see that the skelp is heated precisely to the proper point before it is taken from the furnace. If the temperature is below this point an imperfect weld results, and if overheated the metal is burned or hardened. It is another man's duty to inspect the pipe the moment it leaves the rolls, and to decide instantly and correctly whether the weld is perfect or otherwise. If imperfect the pipe is returned to the welding furnace and is again passed through the welding rolls. These are responsible positions, and men who can fill them satisfactorily need not be out of employment.

Welded pipe is made as small as ¼-inch inside diameter, and as large as 30 inches outside diameter. There is but one mill in the United States prepared to make the latter size. This mill (which is now arranging to rebuild its entire plant at a cost of $10,000,000) contemplates making pipe of 36 inches outside diameter as soon as the necessary equipment can be installed.

The minimum thickness of metal used in making lapwelded pipe is determined by the capacity of the tube to resist collapse when heated to the welding temperature. Standard casing and boiler tubes are close, if not quite, to the minimum thickness.

Lapwelding versus Buttwelding.—For many years the buttweld process of making pipe was confined to the very small sizes, 1¼-inch being the maximum. During recent years, however, the process has been extended to include larger sizes. At the present time it is the common practice among the pipe mills of the United States to make 3-inch pipe and all smaller sizes by the buttweld process, and larger sizes by the lapweld process. This statement applies only to standard pipe, since

the lighter classes of tubular goods can be made only by lapwelding. The strength of a buttweld is dependent largely upon the thickness of the metal, and it would seem that the thicknesses adopted for standard pipe are very close to the minimum thicknesses that can be relied upon to give good results.

While it may be possible to make buttweld pipe larger than 3 inches in diameter, the cost would greatly exceed that of pipe made by the lapweld process, and, therefore, manufacturers have fixed upon 3-inch pipe as the maximum buttweld size, purely for economic reasons. The writer recently visited a mill where 3-inch standard pipe was being made by both processes, and was informed by the superintendent that there is no appreciable difference in the relative cost of manufacture for this particular size.

The question is sometimes asked, "In what respect, if any, is lapwelded pipe superior to buttwelded pipe?" Manufacturers of exclusively buttweld sizes of pipe assert that buttwelded pipe stands the mill hydrostatic test as successfully as lapwelded pipe, which is perhaps true. The severer test of actual use, however, under varied conditions has established beyond a question the superiority of lapwelded pipe. Buttwelded pipe may give equally good service when the conditions attending its use are not unusual, but it should not be used for important pipe lines, if for no other reason than for its tendency to open at the weld when subjected to the excessive torsional or bending stresses which cannot be wholly eliminated in the work of laying, especially where tight joints are an important consideration. Therefore, because of its reliability for work of this character, manufacturers use only the lapweld process in making line pipe.

Pipe Joints.—With reference to the manner of joining the lengths or sections, wrought pipe may be classified as follows:

1. Screw joint pipe, having threaded ends, which usually screw into connecting sockets.

2. Flange joint pipe, having flanges fastened to the ends by one of four general methods, viz.: (a) Shrunk on, then beaded and expanded; (b) screwed; (c) riveted; (d) welded.

Cast iron for ordinary pressures, and cast steel for very high pressures are usually employed for (a), (b) and (c), and forged steel for (d).

Flanges are faced and grooved in a variety of ways, and many kinds of gaskets (such as paper, rubber, copper, asbestos, lead alloys, etc.) are used for making the joints tight.

3. *Lead Joint Pipe.*—There are two well-known types of lead joints used for wrought pipe.

(a) Converse lock joint, consisting of a cast iron hub, with a grooved socket at each end, into which fit two projecting rivets or nipples fastened on the ends of the pipe. After entering the hub the pipe is revolved slightly, thus "locking" the joint, the nipples preventing the pipe from being pulled out of the hub. The joint is completed by pouring full of molten lead, which is afterwards caulked. Each length of pipe is shipped from the mill with a hub on one end. This form of joint has been widely used in all sections of the United States, and for strength and tightness is probably the best lead joint on the market.

(b) Matheson joint, formed by expanding one end of each length to form a bell or socket, which is reinforced by shrinking on a steel band. A groove is cut around the outside of the spigot end.

4. *Special Joint Pipe.*—Under this head may be mentioned the Dresser coupling, which is especially adapted for gas transmission lines. It consists of a cast iron, rubber-packed hub, which can be readily used to connect plain end pipes. The joints are made practically tight by means of bolts. A modified form of this joint, known as the Dresser insulated pipe coupling, has proven to be an excellent preventive of electrolytic corrosion.

Screw Joint Pipe.—With reference to weight, or thickness of shell, screw joint pipe may be divided into four classes of standards:

1. Embracing standard pipe, line pipe, drive pipe and tubing.
2. Extra strong pipe.
3. Double extra strong pipe.
4. Casing.

Taking the weight or thickness of Class 1 as a standard of comparison, and representing it by 1, then extra strong pipe is approximately $1\frac{4}{16}$, double extra strong pipe, $2\frac{8}{16}$, and standard casing $\frac{6}{16}$; or if standard casing is represented by 1, standard pipe is approximately $1\frac{1}{3}$, extra strong pipe, $2\frac{1}{3}$, and double extra strong pipe, $4\frac{2}{3}$. In other words, standard pipe is nearly twice the thickness of standard casing, and about $\frac{1}{4}$ the thickness of double extra strong pipe, of the same diameter. Classes 1, 2 and 3 have the same outside diameter.

The standard pipe of commerce, commonly known as merchant pipe, is of lighter weight than standard weight or full weight pipe. Manufacturers specify that the latter may have a permissible variation of 5 per cent. above or 5 per cent. below the nominal or table weights. Merchant pipe, however, such as manufacturers and jobbers carry in stock, is almost invariably under the nominal weight. The actual weight varies somewhat among the different mills, but usually lies between the limits of 5 per cent and 10 per cent. below the table weight. Line pipe, drive pipe and tubing are full weight, subject to the "permissible variation" of the manufacturer. The same is true of extra strong and double extra strong pipe.

Drive pipe is used chiefly in oil wells, and is designed to stand heavy driving. The ends, therefore, are turned in a lathe, in order that they may meet at the centers of the couplings to form a continuous column, which can be driven without damage to the threads. As tubing is used in wells for pump barrels it is both plugged and reamed to insure a smooth interior.

The smaller sizes of double extra strong pipe are made by driving one piece of extra strong pipe inside of another. The larger sizes, however, are made in the usual way.

Standard casing is the lightest screw joint pipe that can be made. Casing which is made heavier than the standard is termed "special" casing. The increased thickness reduces the interior diameter. Thus, the outside diameter of 5-inch standard casing is 5.25 inches, and the inside diameter is 4.95 inches. The nominal weight is 8.20 pounds per foot. Three "special" weights of this size are made, weighing respectively 9.86, 12.80 and 15.88 pounds per foot. The corresponding inside diameters are 4.87, 4.75 and 4.65 inches, the outside diameter remaining unchanged. This arrangement permits the use of standard casing couplings and fittings for all the special weights of casing having the same nominal diameter.

Oil well casing differs from irrigation casing in having longer and heavier couplings. It is also subjected at the mill to more rigid inspection, as well as to a higher hydrostatic test. Casing is sometimes made to order with *inserted joints*, by expanding and threading the inside of one end and the outside of the other end.

Flush joint casing is also used on rare occasions. This joint is made by removing with a lathe half the thickness of the shell from the outside of the pipe at one end, and from the inside at the other end, and then cutting male and female threads on the respective ends.

Pipe Threads.—Pipe threads are designated by the number of threads per inch. There are 22 sizes of standard pipe between $\frac{1}{8}$-inch and 12 inches, inclusive. As the pitch of the standard pipe thread is approximately the same as its depth, and as pipes of different diameters vary in thickness of shell, it is apparent that the same number of threads per inch cannot well be used for all sizes of pipe. However, only five different pitches are used for the 22 sizes and 21 thicknesses of standard pipe.

Taking 4-inch standard pipe as an illustration, the standard thread has a pitch of $\frac{1}{8}$ inch (8 threads per inch) and is 1.8 inches long. It consists of 8 perfect V-threads, then 2 threads that are perfect at the bottom and slightly flattened on the top, and, finally, 4 imperfect threads, the last of which is but little more than a scratch. This is often referred to as a vanishing thread. Casing threads are considerably finer than standard pipe threads; 4-inch casing, for example, having 14 threads per inch.

The standard pipe thread has a taper of $\frac{3}{4}$ inch per foot. Drive pipe threads are practically straight. The threads on line pipe, tubing and casing have a taper of $\frac{3}{4}$ inch per foot, and the coupling threads are correspondingly tapered from each end of the coupling to its center. The threads of standard and drive pipe couplings are straight. Couplings for oil country tubular goods (drive pipe, line pipe, tubing and casing) and hydraulic pipe (extra and double extra strong) are recessed at the ends.

When the pipes are properly screwed together the recessed ends of the couplings extend beyond the threads and fit snugly to the pipes, thus preventing any bending stresses from reaching the threads. By means of the taper threads on both the pipe and the coupling, a perfect contact is secured for every thread. These two features (the protective sleeve and taper threads) combine to form a joint of maximum strength and tightness.

In threading pipes and couplings the mills work closely to the standards for the several classes and diameters. Excepting the smaller sizes of merchant pipe it is customary among the best mills to screw a thread protector on the exposed thread of each length of pipe, especially for long-distance transportation. Quite a variety of thread protectors are in use, some made of light hoop iron, corrugated to fit the threads, and some of band iron; but for transportation across the Continent to the Pacific Coast only the heavy, half-coupling protector has proven satisfactory.

The fact cannot be emphasized too strongly that approximately perfect threads are a prime essential for making absolutely tight joints in a pipe line. Many leaky screw joints are due to a disregard of this fact. In cutting threads in the field, and even in pipe fitting shops, mill standards are too often ignored. In some cases the perfect threads are quite imperfect, while in other cases some are entirely lacking. Threads of this character are very liable to make troublesome joints.

On the other hand, Mr. R. T. Crane, of Crane Co., Chicago, holds that pipe threads may be quite badly damaged without seriously impairing their efficiency. As an experiment, Mr. Crane "Took an 8-inch coupling and a piece of 8-inch pipe, and throughout the whole length of the bearing of the thread in the coupling and on the pipe made grooves such as are likely to occur when there is a defective weld. The grooves extended about half the depth of the thread, and were made an inch apart for the entire circumference of the pipe. The threads were flattened both on the pipe and in the coupling, excepting a mere speck in each. Also, to offset the broken thread feature of the question, three grooves were cut in the pipe ¼ of an inch wide and the full depth of the thread. This coupling and piece of pipe were then screwed together, and tested to 500 pounds of air, at which pressure the joint was tight, demonstrating conclusively the stupidity of steamfitters and engineers on this subject. * * * The amount of defect on the threads used in this test was at least 100 per cent. greater than that for which the regular steamfitter or engineer will reject material."

The writer believes that Mr. Crane has over-estimated the value of this experiment. It is far from being conclusive. It proves only the possibility of making a tight joint with a thread that is far from being perfect. And while it may serve to show the unreasonableness of condensing threads that are not quite up to the standard of excellence, it does not prove that damaged threads are always to be relied upon to make tight joints. This is especially true of a pipe line, for in the field there are no such facilities for effective work as Mr. Crane evidently had at hand when making his experiment. It is not an easy matter to lay a tight pipe line under the most favorable conditions, although the chances of success are unquestionably better when the threads are in perfect condition than when they are crudely cut or badly damaged.

The holding power or shearing strength of a screw joint is much greater than is generally supposed. When all the threads have the maximum contact (as in taper thread couplings) their combined stripping strength is several times the ultimate tensile strength of the shell of the pipe. This statement applies no less to the fine threads of casing than to the coarse threads of line pipe; but it does not apply to the ordinary straight thread couplings, such as are used on merchant pipe, since in practice the contact area of the threads is somewhat less than in taper thread couplings.

Taking for illustration 2-inch line pipe, and assuming the threads to be in perfect contact, the total contact area approximates 5 square inches, while the metal area of the pipe is 1.07 square inches. Assuming the tensile strength of the metal to be 60,000 pounds, and the shearing strength to be 45,000 pounds per square inch, then the ultimate tensile strength of the pipe is 64,200 pounds, while the stripping strength of the joint is 225,000 pounds. This leaves a wide margin of safety for straight thread couplings, imperfect threads or carelessness in making the joints.

The writer is indebted to a representative of a leading pipe mill for the following description of a series of tests that were made for the purpose of determining the relative strength of taper thread line pipe couplings, and standard, or straight thread, couplings:

Test No. 1.—A piece of 2-inch standard pipe was screwed into a line pipe coupling, and when subjected to a tensile strain broke some distance from the coupling at 65,000 pounds, equivalent to about 60,500 pounds per square inch of metal area. After this test all the pipe and coupling threads were found to be in perfect condition.

Test No. 2.—A piece of 2-inch standard pipe (cut from the same length as the piece used in Test No. 1) was screwed into a standard coupling. It broke in the socket under a tensile strain of 37,000 pounds. This test was repeated, with the result that the pipe was pulled out of the socket by stripping the few threads that were in contact.

Test No. 3.—A 2-inch line pipe coupling was screwed on a piece of pipe by machinery, and the coupling then taken off. This operation was repeated 160 times, after which an examination showed that all the pipe and coupling threads were in as good condition as before the test.

Test No. 4.—The same test as Test No. 3 was applied to a piece of 2-inch pipe and a standard coupling; but while screwing on the coupling the tenth time the pipe broke inside the coupling. These tests demonstrate that, by using taper-thread couplings, the joints can be made stronger than the shell of the pipe, while joints made of standard or straight-thread couplings are the weak portions of a pipe line.

Steel Pipe versus Wrought Iron Pipe.—The crowning achievement of the pipe industry has been the successful use of steel in the manufacture of wrought pipe. This innovation, by one of the leading pipe mills in the early eighties, met with a storm of opposition, not only from rival mills but from engineers as well.

It was represented that a perfect weld could not be made with steel, that steel pipe could not be threaded, and that it was even more unreliable and treacherous when under pressure than cast iron pipe. As late as 10 years ago many engineers refused to accept steel pipe as a substitute for wrought iron pipe, although manufacturers were prepared then as now to prove its superiority. Since then engineers have so universally adapted themselves to the new conditions, that when an occasional non-conformist specifies wrought iron pipe in preference to steel, it is assumed that he has not kept pace with the wonderful progress that has been made in the manufacture of steel tubular goods during the last decade. At the present time manufacturers are producing a uniform quality of steel for pipe, that for malleability, ductility and weldability cannot be excelled by the more expensive product of the puddling furnace, while for tensile strength it is vastly superior to the highest grades of iron.

Many persons are deceived by the high sounding phrase, "guaranteed wrought iron pipe." This class of pipe is seldom made of puddled iron. On the contrary, it is oftener made of re-rolled scrap, which contains a varying percentage of steel. If anyone desires to satisfy himself regarding the sort of product that results from re-rolling a mixture of iron and steel scrap, such as is collected by junk dealers, let him inspect the fracture of an average bar of so-called "refined" iron. He will probably discover that a considerable portion of the area is crystalline in structure, and that the steel crystals and iron fiber have little or no affinity. The same character of material is largely used in the manufacture of the "guaranteed wrought iron pipe" that is sold to the unsophisticated, at a price approximately 10 per cent. higher than that of the best quality of steel pipe.

In 1897, Prof Henry M. Howe, an eminent authority on the metallurgy of steel, made a series of experiments for the purpose of determining the relative bursting strength, tensile strength and frictional resistance of wrought iron and steel pipe. The information derived from these experiments is probably the most reliable and conclusive that has ever been compiled relative to the comparative merits of iron and steel pipe.

Three classes of wrought iron and steel pipe were selected; viz., 2-inch line pipe, 2-inch tubing and 5⅝-inch casing. The wrought iron pipes were obtained from three manufacturers of good reputation, while the steel pipes were provided by the manufacturer who engaged Prof. Howe to make the experiments. Neither the wrought iron nor the steel pipes were made especially for these tests. In his report Prof. Howe states that he selected the 2-inch steel tubing from a large pile at the shipping platform of the mill, and the 2-inch steel line pipe from two large piles at the storehouse, each about 12 feet high and 60 pipes wide. The 5⅝-inch steel casing was selected partly from a pile at the shipping platform, partly from another pile at the mill, and partly as it came from the welding rolls. Prof. Howe took the additional precaution to mark each pipe selected with his private stamp.

Bursting Tests.—The pipes which were selected for the bursting tests were provided with welded heads, after which they were subjected to hydrostatic pressure until they burst, the bursting pressures being determined by a gauge. The highest pressure available was 6,000 pounds per square inch. All of the wrought iron pipes burst below this pressure, while approximately two-thirds of the 2-inch steel tubing, and one third of the 2-inch line pipes successfully resisted the maximum pressure.

The following table shows in condensed form the average results of the experiments:

Bursting Tests by Hydrostatic Pressure.

	Bursting Pressure, Lbs. per Square Inch.		
	2-inch Line Pipe.	2-inch Tubing.	5⅝-inch Casing.
Wrought iron, min.	1,000	3,300	250
" steel, "	2,300	5,150	1,450
Wrought iron, max	4,000	5,000	1,400
" steel, "	6,000	6,000	2,750
Wrought iron, average of all pipes tested	2,918	4,106	931
Steel, average of all pipes tested	4,733	5,800	2,038

A comparison of the average results shows that the steel pipes excelled the wrought iron pipes by 62 per cent. in the line pipe, 41 per cent. in the tubing, and 119 per cent. in the casing.

Tensile Tests.—For making the tensile tests short pieces were cut from certain of the steel and wrought iron pipes. These were accurately threaded and fitted with special extra heavy couplings They were then pulled lengthwise in a tensile testing machine until they tore in two. The stress was noted, and reduced to pounds per square inch of metal area. The average results are shown in tabulated form as follows:

Tensile Tests.

	Tensile Strength, Pounds —Per Square Inch of Net Section.—		
	2-Inch Line Pipe.	2-Inch Tubing.	1⅝-Inch Casing
Wrought iron, min	43,107	47,244	47,312
" steel, "	63,025	60,370	75,931
Wrought iron, max	53,809	55,074	61,309
" steel, "	67,586	66,495	91,591
Wrought iron. Average of all pipes tested.	50,002	51,852	54,311
Steel. Average of all pipes tested.	65,999	63,057	82,355

The table shows that the steel pipes excelled the wrought iron pipes by the following percentages: Line pipe, 32; tubing, 22; casing, 52.

Friction Tests.—Without going into details it may be stated briefly that the friction tests showed that the steel pipes offered less resistance to the flow of water than wrought iron. To quote Prof. Howe, "For a given initial pressure the final pressure is here about 6 per cent. greater in case of steel than in that of wrought iron." The concluding sentence of Prof. Howe's report relative to the above series of tests is as follows:

"To sum up, the steel pipes excel the wrought iron very greatly in bursting strength, very considerably in tensile strength, and somewhat in offering less frictional resistance to the flow of water."

Threading Steel Pipe.—The most common complaint against steel pipe is that it is more difficult to thread than wrought iron. This difficulty can be usually traced to the use of old, worn-out threading tools. Steel pipe is well threaded at the various pipe mills, and is equally well threaded in the best pipe fitting shops. In fact no pipe fitter or pipe layer need have the slightest difficulty with threading steel pipe, if he will take the precaution to provide himself with up-to-date threading tools, and then keep them in good repair.

Corrosion.—Another objection that is sometimes urged against steel pipe is that it corrodes much more rapidly than wrought iron. Of late years this objection has been shown to be based on prejudice rather than fact.

The writer is frequently told that wrought iron pipe is much more durable than steel; but when he attempts to get at the facts his informants invariably fail to furnish any satisfactory evidence in support of their extravagant claims. A mine superintendent recently made the astonishing statement that he knew by experience that wrought iron pipe will last fully twice as long as steel pipe. A brief cross-examination developed the fact that he had used some light sheet iron pipe some 20 years ago in the State of Nevada, and had later used sheet steel pipe in California. He could not remember whether the thickness of metal was the same in both cases or not, and had no knowledge of the chemical properties of the water and soil of the two localities. All that he knew was that the iron pipe lasted twice as long as the steel.

As early as 1895, Prof. Howe, in a paper entitled "Relative Corrosion of Wrought Iron and Steel," summed up his analysis of a considerable number of experiments made by himself and other investigators in the following language: "It is misleading to say either that normal low carbon steel corrodes more or that it corrodes less than wrought iron, since the irrelative corrosion varies with the inclosing medium. I think we have every strong reason to believe that such steel when carefully made resists corrosion in fresh water as well as wrought iron; in cold sea water, at least nearly as well as wrought iron; and in acidulated water better than wrought iron." Five years later Prof. Howe published the results of a series of experiments in which he exposed a number of plates of wrought iron, steel and nickel steel, ¼ inch thick, to the action of sea water, river water and the weather, for two periods of one year each. The results are summed up in the following table:

Corrosive Tests.

	Sea Water.	Fresh Water.	Weather.	Average.
Wrought iron	100	100	100	100
Soft steel	114	94	103	103
3 per cent., nickel steel	83	80	67	77
26 " " "	32	32	30	31

This table practically confirms Prof. Howe's statement of 1895, and should go far toward convincing anyone open to conviction that the difference in the rate of corrosion between iron and steel is hardly appreciable, and that wrought iron possesses no advantage over steel in this respect.

No matter whether we use wrought iron or steel pipe corrosion is a factor that cannot be ignored. Its rapidity of action depends to a very great extent on the chemical properties of the soil in which the pipe is laid. In some soils of California light riveted pipe coated with asphaltum has done good service as water mains for 25 or 30 years, while in other soils the same classes of pipe have lasted less than as many months. How best to protect iron and steel pipe from corrosion has long been a problem that has given rise to much research and experiment. More than 30 years ago the manufacturers of light riveted pipe in California realized that the success of this class of pipe depended upon the application of a satisfactory preservative coating. Judging from riveted pipes that were recently taken up in Oakland, after having been in the ground since the early seventies, it was customary in those days to apply the asphalt coating very generously and with great care. Since the manufacturers of riveted pipe, refiners of asphaltum, and engineers, have devoted much time and thought to this all important subject, and at the present day the coating of steel pipe with asphaltum is probably better understood in California than anywhere else in the world. It is possible to purchase in this market asphalt preparations for coating pipe that will give excellent results if properly used. And here it should be emphasized that, in coating pipe with asphaltum, experience, good judgment and thoroughness are the prerequisites of success. Probably 90 per cent. of the failures of asphalt coating to preserve pipe from corrosion is due to the absence of one or all of these important qualifications. In view of the importance of the subject the following points are suggested regarding the coating of pipe with asphaltum:

1. The pipe should be thoroughly cleaned. Every particle of rust and as much of the mill scale as possible should be removed.

2. The asphalt bath should be brought to a temperature of 300° F. Its proper consistency may be determined by dipping in the mixture a strip of thin steel and then withdrawing and plunging into cold water. If after this treatment the coating is soft and sticky the mixture contains too large a proportion of the fluxing or liquid grade of asphalt, and if in bending the strip the coating shows a tendency to crack and flake off there is an excess of the solid grade.

3. The pipe should be left in the bath until it has had sufficient time to attain the same temperature as the asphaltum. For the heavy types of welded pipe it would be advisable to heat each pipe to the same temperature as the bath before immersing.

4. As a thick coating of asphaltum affords more thorough protection than a thin coating, two dippings are recommended, in which case the first coating should be allowed to harden before re-dipping.

5. Pipe should be coated in the vicinity of the laying. Under no circumstances should it be dipped before leaving the mill, except as a precaution against rusting en route, in which case it should be re-dipped at destination. After the pipes receive their final coat the greatest care should be exercised to prevent abrasion, both in distributing along the trench and in laying. As a final precaution every pipe should be rigidly inspected for abrasions, and wherever exposed the metal should be given two coats of some reputable brand of asphalt paint.

The Sabin pipe coating ("a varnish enamel which is baked on at about 400° F.,") has been used during the past 10 years on several important steel pipe lines of large diameter with excellent results. This process, however, requires an expensive plant, and for that reason is used only in connection with large and important undertakings.

The galvanizing and kalamein processes consist of immersing the pipe in a molten alloy, of which zinc is the chief ingredient in the former process, and tin in the latter.

Anyone of the coatings mentioned, if properly applied, will add very materially to the life of steel pipe. But no known preservative, metallic or varnish, can be relied upon to successfully protect steel pipe from corrosion under *all* conditions of soil and water. Chemists may some day discover a universal remedy that will prove inexpensive and efficacious, but until then we must do the best we can with the methods now in vogue.

Specifications.—Engineers sometimes prepare elaborate specifications for pipe without stopping to consider if they are practicable. So far as the quality of the material and the details of manufacture are concerned, it is always advisable to conform to the practice of the best pipe mills. All grades of steel, for example, are not equally weldable;

Therefore it would be a waste of time to specify steel that could not be welded.

It is always a good plan to obtain from some reputable mill such specifications as are best adapted to the work in hand. Arrangements can then be made to have the pipe made in accordance with these specifications under the supervision of a competent inspector.

So far as testing the pipe at the mill is concerned the standard hydrostatic tests for the several classes of pipe will answer, unless extraordinary working pressures are contemplated. The standard tests are as follows:

Standard, extra strong and double extra strong pipe—		
2-inch and smaller	300	pounds per square inch.
2½-inch and larger	500	" " " "
Line piping—		
6-inch and smaller	1,500	" " " "
7-inch to 12-inch	800	" " " "
Tubing—	2,000	" " " "
Irrigation casing—		
5⅝-inch and smaller	500	" " " "
Larger sizes	300	" " " "
Oil well casing—		
5⅝-inch and smaller	600	" " " "
Larger sizes	500	" " " "

Unless otherwise specified the several classes of pipe are tested at the mill to the above pressures. Arrangements can always be made for special tests when the pipe is to be used under high pressures. In no case should the mill test be less than 1½ times the static pressure.

Specifications for Merchant Pipe.—The following specifications are sufficient to secure a good quality of merchant pipe at the ruling market price. Pipe to be made of good, ductile metal of uniform quality, and to be straight and smooth. Threads to be clean cut in accordance with manufacturers' standard. Couplings to be well screwed on. Jointers not to exceed 8 per cent. of the total number of lengths. All pipe to be subjected to the standard hydrostatic test before leaving the mill.

Specifications for Line Pipe.—Pipe to be made of steel of tough, ductile and uniform quality. Each length to be fitted with a full weight line pipe coupling, the ends of which shall be recessed. The threads of the coupling to taper uniformly from both ends to the center. A half coupling thread protector to be securely screwed on to the exposed end of each length of pipe. None of the pipe to vary more than 5 per cent above or 5 per cent. below the standard weights. Jointers not to exceed 6 per cent. of the total number of lengths. Each length of pipe to be tested at the mill to a specified hydrostatic pressure.

If the pipe is for a high working pressure it would be advisable to specify the physical properties of the material.

Manufacturers' Limit of Guarantee.—Pipe manufacturers are usually willing to replace pipes that are clearly defective, but under no circumstances will they assume responsibility for damages, beyond the price of the pipe. Pipes are used for such a multiplicity of purposes and under such a variety of conditions, that manufacturers have been compelled, as a protective measure, to adopt the rule that "No charges for labor, or expenses required to repair defective goods, or occasioned by them, will be allowed."

The necessity for the adoption of such a rule suggests the fact that serious failures now and then occur in the use of pipe. Such failures, however, are rare, and their occurrence can be made exceedingly improbable if they cannot entirely be prevented, by employing at the outset the services of a competent engineer; one who knows how to secure at a minimum cost the pipe best adapted to the requirements.

In conclusion the writer takes pleasure in acknowledging his indebtedness to Mr. Chas. M. Woods, Manager of Sales, and Mr. Thos. W. Brooks, Assistant Manager of Sales, of the National Tube Company, for the Pacific Coast, for having placed at his disposal certain records of tests made by the National Tube Company, of which he has freely availed himself in preparing this paper.

Mr. George E. Harris, who is well-known in the gas trade from his 10 years' association with the firm of George M. Clark & Co., of Chicago, and who has more recently been Superintendent of the plant of the Marshall (Mich.) Gas Company, will travel in the interest of the Humphrey light, representing the General Gas Light Company, of Kalamazoo, Mich., in the Eastern States and Canada.

The Back Filling of Trenches.

By Mr. W. F. Raymond, Indianapolis, Ind.

There is no work connected with public improvements that has a more important bearing on the durability of pavements than the back filling of trenches, and it is surprising how few men understand the proper way of re-filling a trench. There are, of course, many soils to cope with, but each must be treated on the same general principle; *i.e.*, to fill all the voids, that in every case all the particles may be as close together and as tightly compacted as possible.

Let us suppose the case of an 8-foot trench, in which a 12-inch sewer pipe has just been laid, the soil being all gravel. In the first place the pipe should be well bedded on the sides, the filling material used here should be the finest available and thoroughly tamped with railroad tie tampers, or those of similar structure of iron. Then cover over the pipe about 6 inches and turn on the hose or wet by pall. Great care must be exercised with the water and no more should be used under any circumstances than will seep away, aided, however, by the use of bars to make holes through the filling, going down to the trench's grade on each side of the pipe. Again put in some 6 or 8 inches of filling and again put on all the water it will take. Then put on 3 or 4 inches of loose, dry material and have some 18 or 20 men with iron tampers line up in the trench and hit hard, the first 2 tamping along the walls of the trench, the others following, with orders to vary their courses. Three or four men shoveling into a trench are enough to keep the number of tampers mentioned going, but the stretches back filled at one time should not exceed 200 feet.

This operation of filling in 6 or 8 inches of material with good use of water, followed by 3 or 4 inches of fine, dry material with heavy tamping, should be repeated until within 3 or 4 inches of the strect grade, where, after a thorough tamping—the filling already in the trench having been well moistened, not soaked—some coarse material is spread over it, followed by fine material heaped up about 4 or 5 inches above the street grade. The last should be raked, pulling the coarser material under all the time. After crowning up, a heavy tamping should follow and the edges should be cleaned, after which all should be sprinkled. No trench so filled will be found to sink or settle below grade, and the cost will be found to be less than usual, all things considered, provided the force is well organized and well handled. After a week or 10 days a heavy roller will put the trench to grade (level) and it will hold forever.

With ordinary earth (loam) filling the process of back filling will be identical, but usually the surface course will be of stone or gravel as found in the street. In such cases the raking for this last course will be very important and must be done with great care.

With clay quite a different proposition confronts us. If the clay be dry it should be bedded round the pipe, conduit or arch just as designated for gravel. Then should come a covering of the pipe and the tampers should be put to work, the clay having first been leveled in the trench. After thoroughly tamping, the water should be copiously used, but not in sufficient quantity to cause "sponginess." After the first wetting another course of clay of 8 or 10 inches, then tampers, then water and so on until the trench is filled to within 4 or 5 inches of the top. Here a heavy wetting is given and the bars are used to make holes to allow the water to permeate thoroughly through the new back fill. The top course should be done in the same manner as described for gravel, though if naught but clay is at hand use only the finest, tamp it thoroughly and do not wet save for a light sprinkling to bond the material together.

The clay, if heavy, should never be puddled (a term used to designate a heavy soaking with water) for the reason that the water will go rapidly to the bottom of the trench and is sure to cause spongy, soggy places. Whenever or wherever the condition of sponginess is found, especially in a trench through a street which is to be immediately improved, the entire mass of spongy material should be removed, and good, clean gravel or broken stone used in its stead and thoroughly rammed in courses.

In all cases where the soil is mixed, say, gravel, clay and sand, or sand and loam and clay, the finest and driest loam should be put first in the trench, round the pipe and wet, the clay should come second in all cases, then the sand. Or if gravel is found in the combination of material start and finish with gravel. In case sand and not gravel is found, after the sand has been put on the clay a good wetting and plenty of bar work will fill all voids, then in the last few inches a mixture of the finest clay and sand, moistened a little, will afford a good wearing surface for such material.

Good judgment must at all times be exercised in separating the various kinds of material which come out of a trench while excavating. Great care must also be exercised in putting the material back in proper sequence, that the most compact fill may be obtained for the least labor and cost.

Many will contend that the tampers are unnecessary and expensive, and that water, and plenty of it, will do more than can be accomplished by 40 tampers per 1,000 feet of trench. To all such the assertion is made that with a force of 40 men not less than one-quarter of a mile of trench a day should be back filled, and done in such a way as will preclude all possibility of settling or sinking, conditions adding to "after-cost" and maintenance.

Wherever stone are found they must be used far enough up in the trench to avoid any chance of damaging pipe, conduit or arch. Fine material must cover the stone and such fine material must be well watered and worked with the bars. The bar work is far more important than it seems and must be well done for successful non-settling back fills.

Whenever back filling material has become thoroughly soaked by rains, special care must be taken to have coarse and fine material mixed while being shoveled into the trench, as the voids are thus best filled under such conditions. The chief compression in these cases comes from the tampers, and to avoid "picking up" (sticking) a little gravel or sand is used to good advantage under the tampers. In back filling a trench where naught but wet clay is found, perhaps the most difficult back filling proposition is encountered. Too much water will surely cause sponginess, too little will leave many voids and the trench must needs settle, so what is the best course to pursue? Fill in with the clay a few inches only at a time, cut it down with shovels or spades, have it thoroughly tamped and repeat until filled, after which a judicious amount of water with bar work, the top course if possible being delayed for a day or two.

When return buckets are used in trench work no system of back filling is more satisfactory and efficient than leveling the material a little and applying water through a hose, with good use of bars added; in this case, also, the last 3 or 4 inches should be treated as described for loam or gravel. In all very wide deep trenches where sheathing is used no system can be employed which will prove more satisfactory than thoroughly wetting and tamping, using as much fine filling as is possible to find, but the point cannot be too strongly emphasized that too much water is worse than none, so a clever man of good judgment should be chosen to officiate with the hydrant and hose.

The writer has seen many miles of trench over a conduit, through all kinds of digging, rock, loam, clay, sand and gravel, which have been back filled as described above, and not one foot ever settled an inch below the street grade, save some 300 feet, which was filled with lumpy frozen loam in zero weather. Back filling is much neglected and far too carelessly done in almost all cities and towns; as a consequence many low spots and depressed, defective pavements are found in streets.

Engineering English.[1]

By Mr. T. J. Johnston.

This paper is a corollary of the discussion at Great Barrington last summer, and refers to only one subject which should be included in the curriculum of an engineering education, that is, the English language.

It should be self-evident that the first preparation of the engineer for his profession is to acquire a knowledge of his vernacular, the "first tool of the mind." It has been well said that one who thinks clearly can speak clearly; in fact, we cannot know that the man's thought is clear until he expresses it so that we, having regard to our own limitations, can understand it. That this is true will be borne in upon anyone who is required to consult engineers about what has happened at particular dates. Everyone knows the difficulty of proving precisely the events of long ago; but here I do not refer to the fallibility of the memory, but to the mere expression of ideas. It is a common thing that no two engineers describing the same phenomenon will give anything like the same description, and this is due not to their want of knowledge of the phenomenon, but to the inaccuracy of their language. That I am not alone in this view is evident from the expressions of competent authorities. I may instance an article of Prof. H. W. Wiley in *Science* for November 28, 1902, page 845, where he says:

"I have often been mortified at the English composition of college and even university graduates. Men who have attained eminence in particular branches of study often seem incapable of expressing their thoughts in any proper way. Their English is inexact, clumsy and inconsequent. Clear expression seems to me to be the legitimate outcome of clear thinking, and the neglect of those early studies which enable one to express himself clearly and forcibly is a fault which can only be remedied by long years of mortification and hard labor."

I also cite the address of Prof. John Perry to which Mr. Mailloux referred in the Great Barrington discussion:

"Only one subject—Latin—is really educational in our schools. I do not mean that the average boy reads any Latin author after he leaves school or knows any Latin at all 10 years after he leaves school. I do not mean that his Latin helps him even slightly in learning any modern language, for he is always found to be ludicrously ignorant of French or German, even after an elaborate course of instruction in these languages. I do not mean that his Latin helps him in studying English, for he can hardly write a sentence without error. I do not mean that it makes him fond of literature, for of ancient literature or history he never has any knowledge except that Cæsar wrote a book for the third form, and on English literature his mind is a blank. * * *

"I ask for a return to simplicity of system. English (the King's English; I exclude Johnsonese) is probably the richest, the most complex language, the one most worthy of philologic study; English literature is certainly more valuable than any ancient or modern literature of any other country, yet admiration for it among learned Englishmen is wonderfully mixed with patronage and even contempt.

"Well equipped schools of applied science are getting to be numerous, but I am sorry to say that only a few of the men who leave them every year are really likely to become good engineers. The most important reason for this is that the students who enter them come usually from the public schools; they cannot write English; they know nothing of English subjects; they do not care to read anything except the sporting news in the daily papers; they cannot compute; they know nothing of natural science; in fact, they are quite deficient in that kind of general education which every man ought to have."

I do not mean by this criticism that engineers should spend long periods in learning the grammatical and rhetorical construction of the language; but I do mean that English composition should be kept up in engineering schools and that engineers should be drilled in the use of English until they can express with entire accuracy the meanings which they so often commit to formulæ. Pick up any engineering article, and one may rarely read a page without some blunder appearing which spoils the sense either by not saying what the engineer means or by saying what he does not mean.

"Have something to say, and say it," was the Duke of Wellington's theory of style. Huxley's was "to say that which has to be said in such language that you can stand cross-examination on each word." This is the secret of his lucidity.

To show how far from the criteria of style of either the "Iron Duke" or Mr. Huxley our engineers are, I quote a few examples of engineering English:

"Generator dissembled."

"More customers, cheaper the cost of production."

"Formerly the slag of steel works was considered purely a dead waste, but some few years ago its valuable fertilizing value was discovered, and now this formerly valueless waste is one of the world's most valued fertilizers."

"Such schemes as M.——'s is not a solution."

"A body like you propose."

Of certain generators, it was said they "cannot be run in parallel."

"This operation is to be operated at every station."

"In a shaft 8,000 feet deep the cost of cooling the temperature would be considerable."

"How much we have had to pay because of the slow speed."

"Details as to how small turbines could be manufactured."

"Encourages attack upon the doctrine of the right * * * to control their business * * * "

"This discharge took place perfectly regular."

"There is no reversing plugs."

"For which the unenviable distinction of being the worst in the world is often claimed for it."

"To this was added two * * * generators."

"Gas engine would develop along the same lines as the steam engine had done."

1. Paper presented at the 20th Annual Convention of the American Institute of Electrical Engineers, Niagara Falls, July 8, 1903.

"The low height of the turbine permitted a reduction of the height of the engine room."

"The correctness of my conclusions have been amply demonstrated."

"This can be done equally as well with the motor at no load as at full load."

"Four motors * * * will perform a faster schedule."

"An almost infinitestimable amount."

"The last two-thirds" (of a communitator brush).

"The matter of convenience * * * is shown in every detail."

"Brackets cast solidly with frame."

"The rings * * * are circular in shape."

"One and the same motor."

"The car is well lit."

"Not only securing pole (pole-piece) but also of drawing same down to the tightest of magnetic contacts."

"The cost of superimposing a second floor on the present system would cost as much as the original cost of building the present system."

"The company finds it impossible to buy only at retail prices."

"Which renders great economy and rapid construction."

"The three top voltages were the * * * ones * * * used."

"Trains can run at fast speed."

"The hollow of both electrodes communicate with the open air, and when in contact form an airtight joint."

"Their errors" (of electrical measuring instruments) "were determined by taking them to the works of the Weston Company."

"Continued to do good work when pronounced as ruined."

"We do not think present conditions demand."

"A fewer number will perform a given amount of work four times as long as any other cell of equal size."

"There is no question but that."

"It would have been better to have had."

"Why does a cell constant change when the density of the solutions change?"

"The lapse of time which are here chiefly in question."

"Not yet fully decisive."

"The correct solution for the problem of cause has been discovered."

These (about 5 per cent. of those I have seen) have been gleaned since the Great Barrington discussion, from reports of engineers, descriptions of operations furnished to engineering periodicals by engineers in charge, and, "woe is me," from letters to the technical press written by professors of applied physics in universities! I regret to say that some of the most glaring solecisms are from the last named source.

Wendell Phillips once said that there were only 37 jokes in all languages, but Mr. Phillips died before electrical engineers had written much.

It is only necessary to refer briefly to the inaccurate use of terms common in the profession, and particularly to double meanings applied to well known words which should be terms of precision. "Static transformer," when stationary transformer is meant; the "capacity" of a system, when the maximum output is meant; the "field" of a generator, when the field magnet is meant, are common examples of the appropriation of a well known term to a new use, generally inaccurate. "The time would fail me" to do more than shake hands with our old enemies. "Equally as well," "the two highest," "one and the same," *et id omne genus.*

I see many mining engineers in the course of the year. Respectable vagrants as they are, their correct and often elegant diction is a surprise and a pleasure, and somewhat of a reproach to our own members; though a mining engineer, to be sure, would have but a dry practice if he could not furnish the materials for a good prospectus.

This is no protest against the study of languages other than English. *Per contra*, just as no man can be a sound mathematician who confines his study to algebra or trigonometry, so no man can learn English thoroughly without some comprehension of its sources in other languages. The true meaning of a word can only be learned by learning its root, and from that its trunks and branches are easily understood.

Let no man say, "I am too old to take up such studies; they were neglected in my youth, and I am as I am." Caleb Cushing, Attorney General of the United States, statesman, diplomat and jurist, learned in literature and science, began the study of French when he was 70 years of age. The subsequent proceedings are not generally referred to, but having heard Mr. Cushing's French, I may add that, although public safety prohibited his pronunciation, his knowledge of the shades of meaning of the spoken language would have shamed many English speaking persons long resident in France.

Most of the errors in engineering English are due to want of attention; few engineers revise the language of their reports and articles as they do the tables and formulæ upon which the text is based; fewer still, even in important investigations, think it worth while to have the text read by another to detect errors.

I may quote from President Woodrow Wilson's inaugural his unanswerable plea for a liberal education, as a special plea for adequate instruction in English, either as a preparation for, or better still, for both that and a part of an engineering course:

"No doubt the old, purely literary training made too much of the development of mere taste, mere delicacy of perception, but our modern training makes too little. We pity the young child who, ere its physical life has come to maturity, is put to some task which will dwarf and narrow it into a mere mechanic tool. We know that it needs first its free years in the sunlight and fresh air, its irresponsible youth. And yet we do not hesitate to deny to the young mind its irresponsible years of mere development in the free air of general studies.

"What we seek in education is a full liberation of the faculties, and the man who has not some surplus of thought and energy to expend outside the narrow circle of his own task and interest is a dwarfed, uneducated man. We judge the range and excellence of every man's abilities by their play outside the task by which he earns his livelihood. Does he merely work, or does he also look abroad and plan? Does he, at least, enlarge the thing he handles? No task, rightly done, is truly private. It is part of the world's work.

"A merely literary education, got out of books and old literature, is a poor thing enough if the teacher stick at grammatical and syntactical drill.

"It is not the education that concentrates that is to be dreaded, but the education that narrows—that is narrow from the first."

Do we not all assume too readily that because we speak, or think we speak, English, our expression of the thought in our minds is impeccable? Is not our vocabulary too strictly professional? Does it not cramp the intelligence and impair perception? Ought we not to "break their bonds asunder" and learn thoroughly to use the master tool—English?

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. D. F. BURRITT, for several years Superintendent of the Rockingham Light and Power Company, of Portsmouth, N. H., has been appointed Superintendent of manufacture and distribution to the Springfield (Mass.) Gas Light Company.

AT a recent meeting of the Borough Council, of Chatham, N. J., a franchise was passed permitting the Morristown (N. J.) Gas Light Company to extend its mains to and through the streets of Chatham.

THE following, concerning the site of the new works for the Consolidated Gas Company, of this city, is from a recent issue of the Long Island City (L. I.) *Star:* "The work which is now in progress for the plant of the Consolidated Gas Company on what was formerly known as the Woolsey Estate, covering an area of nearly 400 acres and stretching out from the old Shore road to Steinway creek and Berrian's island, L. I., will, when completed, completely revolutionize one of the oldest and most interesting and picturesque sections of Astoria. The broad expanse of country which years ago formed one of the handsomest estates near New York city is now being leveled, flat as a billiard table, preparatory to commencing the erection of the immense buildings which will be necessary for the conduct of the gigantic operations of the Company. The hill back of the site of the Woolsey mansion is being cut down and hundreds of men and horses and carts are working there steadily day after day under the direction of Superintendent Burden. It is a busy scene, as the operations are being pushed forward as rapidly as possible in order to facilitate the removal of the gas plants from Manhattan. Long trenches are dug in the surface of the hill and then transverse lines are cut across, dividing the ground into sections that are more readily and systematically cleared than by any other process. The earth is carted away and dumped upon the low-lying portion of the property nearer to the river and Berrian's creek. For the past two years the Company has been steadily filling up what was known years ago as Pike's meadows with ashes, and the old swamp is surely and rapidly disappearing. Facing the Shore road a splendid bulkhead is being constructed, starting from a point near the old Woolsey gate house and continuing in the direction of Woolsey's Point. Cribs are being built and sunk, and the outer line of the bulkhead is already commenced. There is every evidence that the Company intends to spare neither time nor expense to expedite the erection of its mammoth plant at Astoria. But to the reminiscent Astorian the changes that are now taking place in this beautiful section cannot but cause a feeling of regret that the inevitable march of time and the progress and development of the locality have rendered this transformation necessary to meet the requirements of the present day. The old resident of Astoria will recall when the Shore road was one of the beauty spots of New York. But how it is changed. The Hoyt mansion was destroyed by fire, and no attempt has been made to restore it. The lawn sloping down to the

river's edge, where General Newton's little daughter set the spark in motion that destroyed the rocky barriers in Hell Gate, is now ragged, torn, unkempt and neglected. The old Woolsey manor house is simply a recollection. The lodge house still remains, but it is in a sadly dilapidated condition. The boat house is gone and the dock is crumbling slowly but surely away. The stone wall, as it used to be called, which stretched from the Woolsey dock to Henry Barclay's house, is in ruins. The Potter place was burned down years ago, so that it can scarcely be recalled at this time. The Barclay mansion is still in good shape, but the old family with whose name it is associated does not reside there now. The big square brick house with broad piazzas in the front and rear, where Abram D. Ditmars, the first Mayor of Long Island City, and his family resided, is now in charge of a caretaker. Another mansion, which formed part of the Barclay estate and which is occupied by Mr. Charles A. Mattman, Superintendent of the Astoria Silk Works, remains, and the grounds and buildings present a pleasing appearance. Mr. Pliny Freeman resides in the old Nesbitt house, with its white columns and attractive Colonial style of architecture. The former residence of Mr. Henry Polhemus still stands near Wolcott's lane. Perhaps one of the prettiest of the family residences remaining along the Shore road is that occupied by Mrs. George A. Trowbridge. The house is one of those charming old-style structures with long sloping roofs, where the birds love to nestle and the ivy clings to the walls, that are singularly attractive. It is well kept, and the dock which is opposite the house is also in good condition. The Turner house, where Judge Shipman lived for a while, remains, but that practically ends the list. The Casina farm, which formed part of the Woolsey estate is next in order and that has been absorbed by the Company. The only buildings remaining of the Woolsey property are the little gate house and the gardener's cottage. The rest have disappeared."

THE Pasadena (Cal.) Consolidated Gas Company is selling gas for fuel at the rate of $1 per 1,000 cubic feet. The Company further announces that on October 1st the rate will be made 95 cents per 1,000.

AT the annual meeting of the Consolidated Gas Company, of Pittsburg, Pa., the Directors elected were: J. H. Reed, J. D. Callery, C. S. Mitchell, Robert Young, C. J. Braun, Jr., and J. F. Guffey.

UTICA, O., is to have a gas plant. At least that is what Mr. E. W. Crayton, President of the Newark (O.) Real Estate and Improvement Company, says.

THE capital of the Battle Creek (Mich.) Gas Company has been increased from $100,000 to $200,000.

THE business of the Brattleboro (Vt.) Gas Light Company has been so prosperous for the last year that the Directors have decided to increase the dividend rate.

MR. J. SNYDER, Secretary of the Norfolk (Va.) Gas Company, has been examining the field at York, Neb., with a view to the establishment there of a gas plant.

THE Bridgeport (Conn.) Gas Light Company, owing to the demands upon it for gas, has been obliged to overhaul the plant of the Citizens Gas Company—an opposition concern started there some years ago, the property of which eventually came into the possession of the old Company—to be up to the situation.

THE following is from the San Francisco *Examiner*, of recent date: "When spoken to in regard to the alleged repudiation by the San Francisco Gas and Electric Company of the 75-cent rate contracts entered into with consumers by the Independent Gas and Power Company before its absorption by the San Francisco Company, Allan Pollok, Manager of the latter Company, retracted his criticism of Mrs. Aronson, of 454 Devisadero street. It was owing to Mrs. Aronson's refusal to pay a bill presented for gas at the rate of $1 per 1,000 that the matter was brought before the public. She insisted that the terms of her contract with the Independent Company, whereby the rate was to be 75 cents per 1,000, should be complied with, notwithstanding the absorption of that Company by the San Francisco Company, and in accordance with an advertisement to that effect inserted in the *Examiner* shortly after the consolidation. 'If I said that Mrs. Aronson was foolish to refuse to pay the bill, I wish to withdraw the criticism,' said Manager Pollok, 'for I realize that we have no right to suggest or dictate a mode of action to one of our patrons. I merely meant that it appeared to me that the wiser course would have been for her to have paid the bill without attempting to arrange the matter with the collector, and to have discussed the situation later with some one in authority. All I wish to state in regard to our attitude is that the San Francisco Gas and Electric Company intends to honor all contracts made before consolidation by the companies recently absorbed.' C. M. Hunt, General Manager of the Independent Gas and Power Company, and whose signature appears upon the 75-cent rate contracts in dispute, was also seen in regard to the matter. 'The difficulty is merely due to the fact that the transfer is not yet completed,' he said. 'There are many matters as yet unadjusted, that of supplying gas at the 75-cent rate to those holding contracts for such terms among them. Our work, which had proceeded to a considerable extent, was naturally interfered with by selling out to the San Francisco Company. I feel sure that there was no disposition or attempt upon the part of that Company to repudiate our contracts, but that the difficulty was due to ignorance on the part of the collectors of the nature of the situation. They are given a bill to collect, and it is their duty to collect it. They do not, of course, understand the conditions of the consolidatiou. But as soon as these are satisfactorily arranged all matters will be adjusted and contracts made by this Company previous to the transfer honored.'"

THE Nassau County Gas Company, of Hempstead, L. I., has applied to the authorities of that village for permission to absorb the properties, rights and privileges heretofore possessed and owned by the old Hempstead Gas Light Company. The succeeding Company proposes to extend its mains through Nassau county.

MR. G. W. PEPPER, Receiver for the Bay State Gas Company, of Delaware, has posted notices announcing the sale at public auction of certain properties supposed to be owned by the Company. The list includes the real and personal property vested in the Oxy-Hydrogen Gas Company, of Wilmington, Del. The sale was originally posted for Thursday next.

IN accordance with the terms of its charter, the Washington (D.C.) Gas Light Company has submitted to the Commissioners a statement of its receipts and expenditures for the fiscal year ended June 30th. According to the statement the receipts from all sources were $1,462,351.24, and the expenditures amounted to $1,448,795.27.

MR. EDWIN EVANS has resigned the position of Superintendent of the gas division of the properties of the Willimantic (Conn.) Gas and Electric Light Company. His successor is Mr. Arthur T. Jackman. Mr. Evans' retirement is due to poor health.

A CORRESPONDENT in Portland, Ore., forwards the following: "Installed in new and splendidly furnished quarters, the Portland Gas Company is keeping open house to-day and welcoming many old and new friends. The modern home of the Company is pronounced the best of its kind on this Coast, and certainly an inspection of the refitted offices on the ground floor at the corner of Fifth and Yamhill streets bears out this assertion. There were numerous callers at the offices on opening day incited to make an examination of the luxuriously finished interior by a desire to see some late artistic effect in office equipment, installed by the Northwest School Furniture Company. A remarkable advancement has been made in the development of the gas corporation's business since the days when it was established in contracted space down on Second street. In the new building opposite the 'Goodnough' the floor space is 50 by 100 feet, whereas in the building just quitted the available room was 50 by 50. This, together with abundance of light from a nearly all glass front, richly paneled ceilings, decorated in the latest style, tapestry covered walls, also paneled with oak moulding, tastefully fitted display rooms and plenty of counter room where the wants of customers may be expeditiously attended to—all this combines to make the offices of the Company something out of the ordinary. The office furniture is of quarter-sawed, polished oak, and the arrangements for handling a large amount of business are equal to those of a bank. In transferring to new quarters the management has instituted a number of changes. The city has been districted in a convenient way, so that a patron will be detained the least possible time in finding out what he desires to know. The business of East Portland, the district north of Alder street on the West side, and south of Alder, will be taken care of in different departments. There is a department for the cashier, a wide window for applications and another one for complaints. There is, also, a separate apartment for the collectors and salesmen, the whole being most conveniently divided. The headquarters is provided with a private telephone exchange, with a central girl in charge, and customers and those in search of information will hereafter be instantly connected with the proper department. The department wherein are displayed stoves, heaters, ranges, hot water heaters and the like, is 25 by 25 feet, and here is shown a full stock of all the modern ideas that have been utilized in the use of gas for cooking, heating and lighting. The Manager says there is not a successful appliance on the market that they have not got. Everything from a cooking range to an instantaneous water heater is shown. The display stock includes late things in chandeliers, antique brasses, oxidized copper, polished brass, Dresden gold and burnished gilt. In the office is displayed a number of the Humphrey gas arcs, of which 500 are in use in this city, and the use of the lamps is extending rapidly. The Company will make a specialty of installing all sorts of fixtures in offices and residences. The offices are a credit to the Company and an ornament to the city."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

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MONDAY, AUGUST 17, 1903.

The Market for Gas Securities.

The slump in stocks and bonds culminated last Tuesday. Faith, hope and cash then came to the rescue of quotations, with the result that the pious have added to their fiscal funds of holiness. Meantime the half-poor that were are needier than ever. Give them more libraries, so that their mentality may not go altogether astray, and supply them with more tonics, in the shape of steel and iron, that their bodies may be kept strong.

The net result of the trading in Consolidated gas for the week is 8 points, in Brooklyn Union nominally nothing. The regular quarterly dividend of 2 per cent. on the latter has been declared, and the shares are quoted at 190 to 205, ex. Peoples, of Chicago, is 94⅞ to 94⅞, ex. It is still very cheap. No one could make any mistake through buying any gas stock just now.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

AUGUST 17.

☞All communications will receive particular attention.

☞The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	179¾	180⅛
Central Union, Bonds, 5's	3,000,000	1,000	109	111
Equitable Bonds, 5's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	299	320
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. .. Bonds, 5's	11,000,000	1,000	107¼	108
Northern Union, Bonds, 5's	1,250,000	1,000	106	107
New York and East River Bonds 1st 5's	3,500,000	1,000	110	113
" 1st Con. 5's	1,500,000		109	111
Standard	5,000,000	100	135	140
Preferred	5,000,000	100	155	170
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	190	205x
" " Bonds (5's)	15 000,000	1,000	119	119¼
Bay State	50,000,000	50	⅛	3/16
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000.000	1,000	47⅛	50
Buffalo City Gas Co.	5,500,000	100	3¾	4¼
" " Bonds, 5's	5,256,000	1,000	73	76
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central, San Francisco	1,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	20,500,000	100	95	95¾
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¾	89¼
Preferred	3,026,500	100	107½	109
Consumers, Jersey City Bonds	600,000	1,000	100	102
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	66¾	68
Mortgage, 6's	3,600,000	..	..	115
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	85	87
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	87	95
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	251,000	1,000	77	79
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	56	60
" Bonds, 6's	2,650,000	..	104¾	106
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	79	90
Preferred	2,500,000	100	85	..
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100	.	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	130	140
Madison Gas & Elec. Co. " 1st Mtg. 6's	350,000	1,000	107½	108¼
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	184¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¼
New Haven	1,000,000	25	300	325
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	.
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	94¾	94⅞x
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	0,000,000	100	51½	52
St. Joseph Gas Co. " 1st Mtg. 5's	751,000	1,000	95	96½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	92	93
Syracuse, N. Y.	1,975,000	100	46	48
Bonds	2,047.000	1,000	98½	99½
Washington, D. C	2,000,000	20	292½	295½
First mortgage 6's	600,000	..	..	..
Western, Milwaukee. Bonds, 5's	4,000,000	..	109¼	110
Wilmington, Del.	600.000	50	232	..

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1469-3

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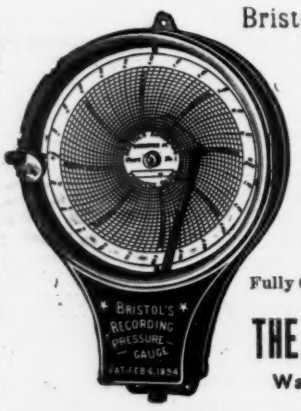

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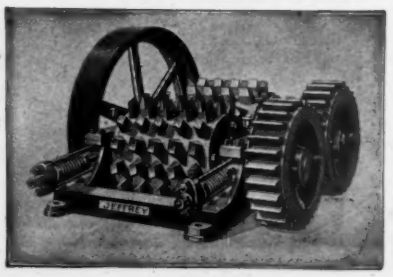

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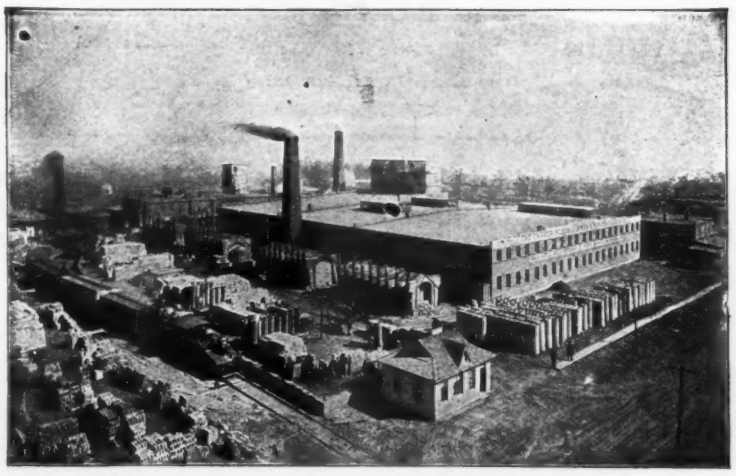

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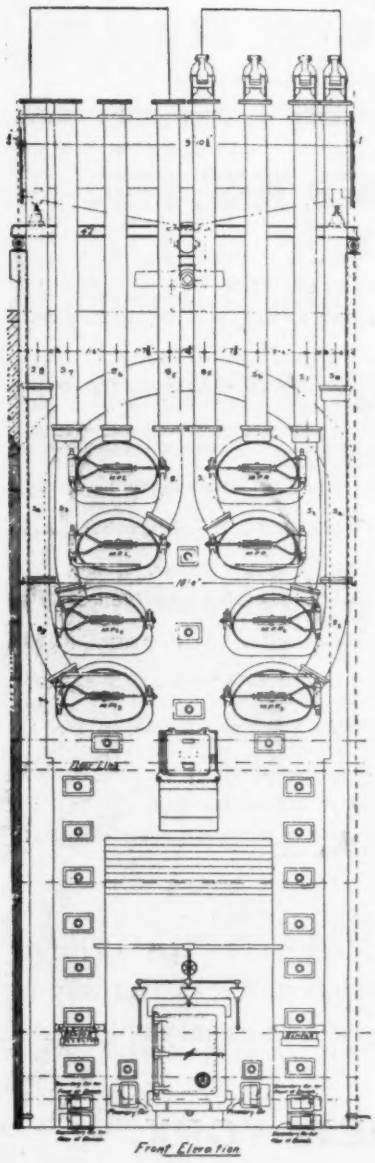

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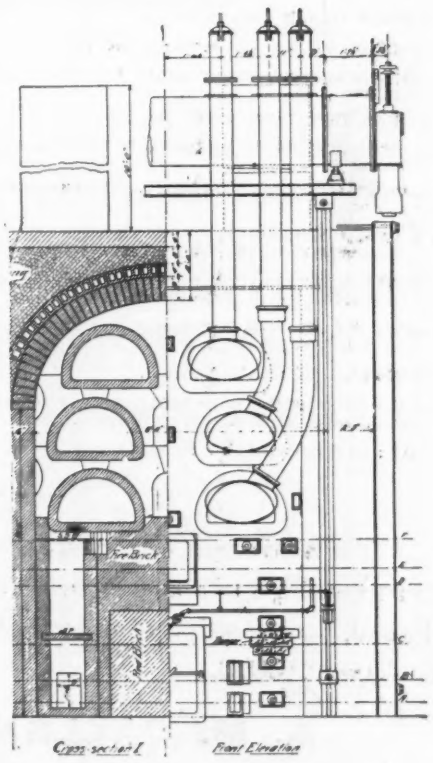

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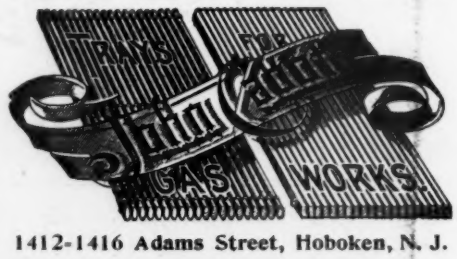

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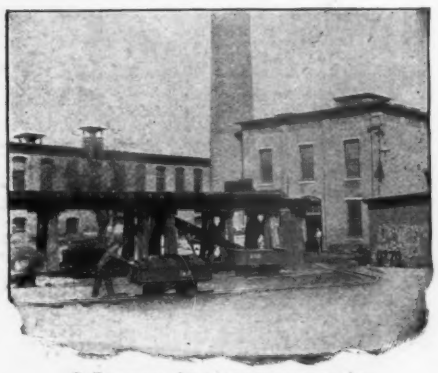

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(Trade-mark)

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For the economical and rapid handling of coal in boiler rooms. A narrow gauge railway, equipped with cars, designed so that they run around a curve of 12 feet radius as easily as a wagon turns a corner.

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New York Office: 45 Broadway.

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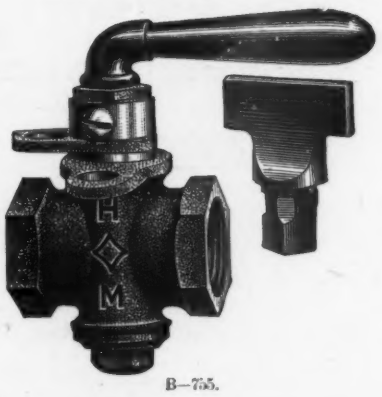

B—755.

TOO little is not as much as you pay for, and too much is more paid for than you need.

In **Mueller Gas Cocks** you find a happy medium--not so little metal as to leave them weak, nor yet so much as to make them costly.

Made in 145 styles, seven sizes in each style.

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Double and Single Gate Valves, ¼" to 72",

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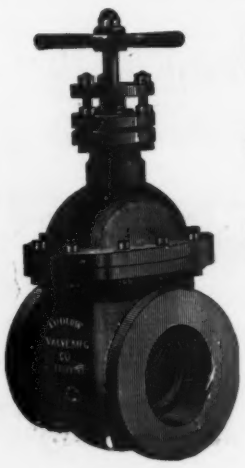
Gas, Water, Steam, Oil, Ammonia, Etc.



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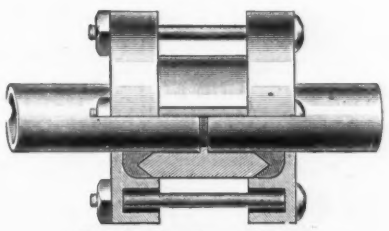
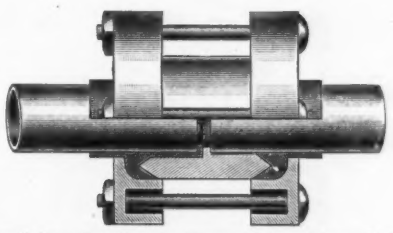
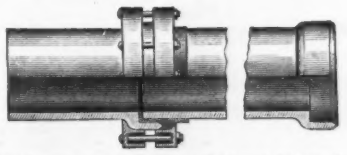


Regular Coupling. Style 1.

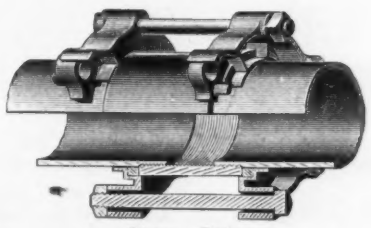


Insulating Coupling for Wrought Iron Pipe. Style 5.



Insulating Coupling for Dresser Bell and Spigot Cast Iron Pipe. Style 6.

Regular Sleeve. Style 2.



Clamp. Style 4.

Pipe Couplings, Sleeves, Clamps, Crosses, Tees and Ells.

My Insulating Coupling prevents the destruction of pipe by electrolytic action, in either water or gas lines.

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LOWE DOUBLE SUPERHEATER WATER GAS APPARATUS.

Coal Gas Condensing and Scrubbing Apparatus.
Purifiers with Plain or Reversing Center Valves.
The Lloyd System of Valve Connections.
PLAIN OR REVERSING (PATENT APPLIED FOR).
Oxide, Coal and Coke Elevators and Machinery.
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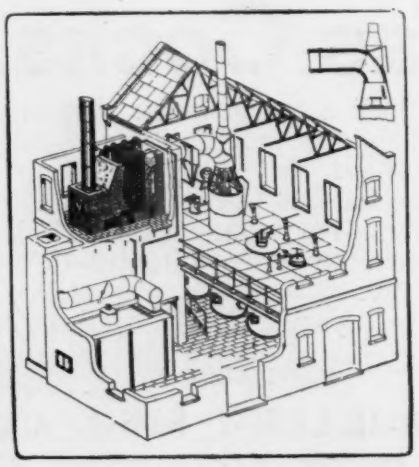
Economize Heat in Water Gas Plants,

BY UTILIZING A

Green's Economizer,



To absorb the heat now going to waste when you blow through your superheater to heat the feed water for your boilers to the temperature of the steam. This is now being done at the Poughkeepsie Gas Works, Poughkeepsie, N. Y. : : : : :

Write for full particulars how this is accomplished, the saving effected, and the advantages gained, to the

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Plans prepared and Estimates furnished at short notice.

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Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.
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THE PURIFIED GAS REVIVES THE FOULED OXIDE.

THE GAS ENGINEERS' POCKET-BOOK.
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NEW GAS EXHAUSTER.

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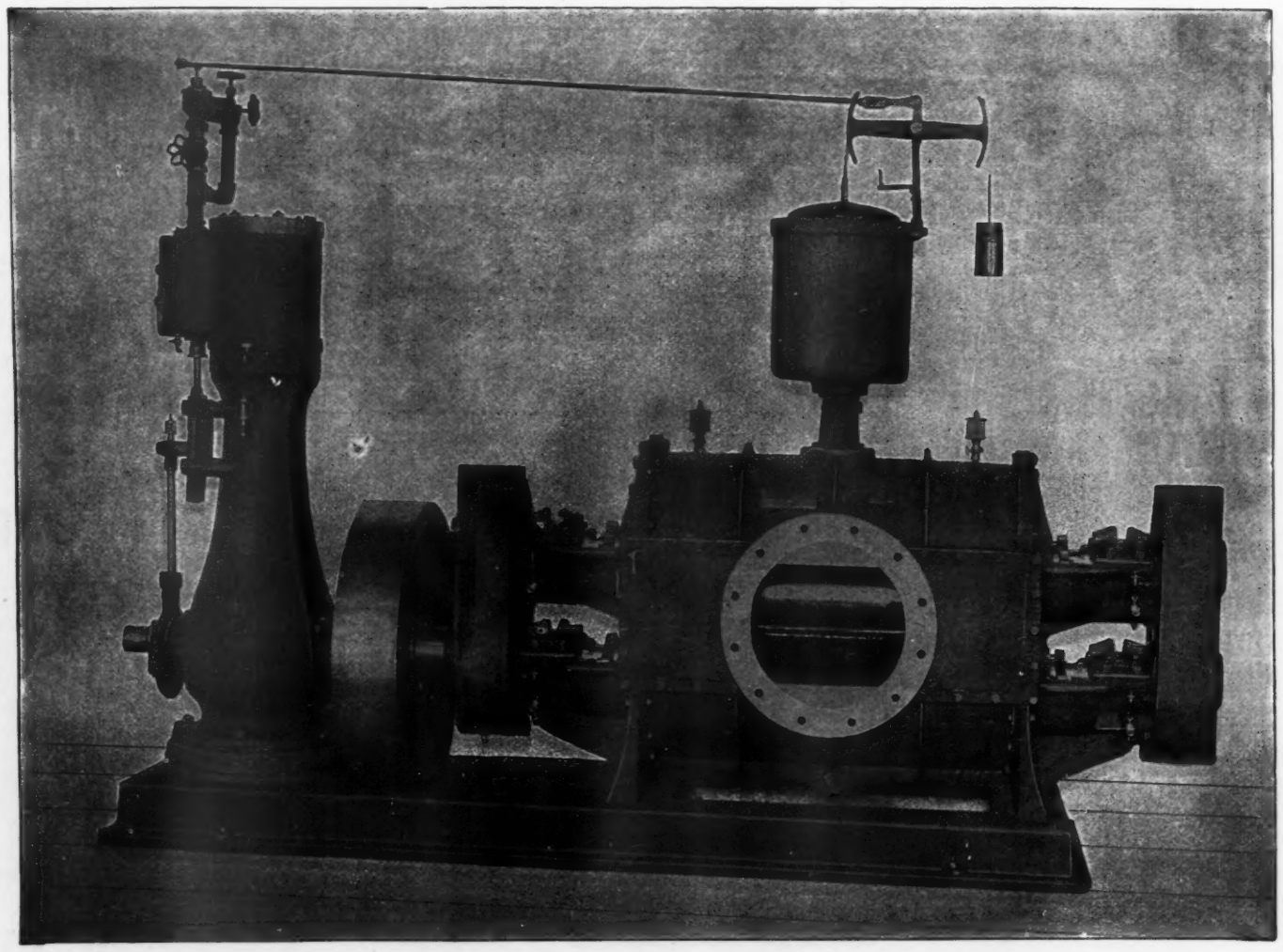
OUR GAS GOVERNOR IS MAKING FRIENDS EVERY DAY.



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GAS TAPPING MACHINES

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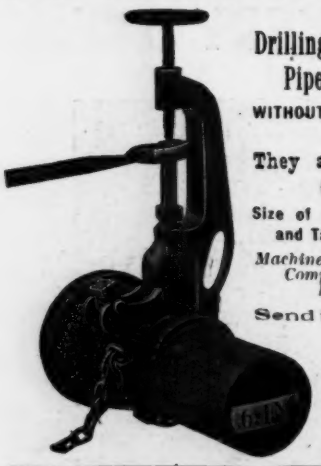
WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

Send for Circulars.



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Builders of UP-TO-DATE Machinery and Appliances for Coal and Water Gas Plants. :: :: :: :: ::

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Valuation of Gas, Electricity and Water Works

FOR ASSESSMENT PURPOSES.

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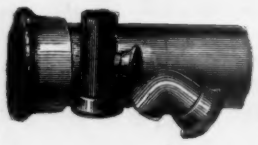

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SAFETY GAS MAIN STOPPER COMPANY,

For Shutting Off Gas in Mains

Any size gas main can be shut off in 30 seconds. : : :

Temporarily during alterations and repairs. : : : :

STOPPERS SENT ON TRIAL.

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Humphrey Crescent Instantaneous Water Heater

IS A QUICK SELLER.

PRICE,

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SHELF AND BRACKET FREE.

HAS NO EQUAL AT THE PRICE.

TRY ONE AND BE CONVINCED. WILL SEND ON 60 DAYS' APPROVAL.

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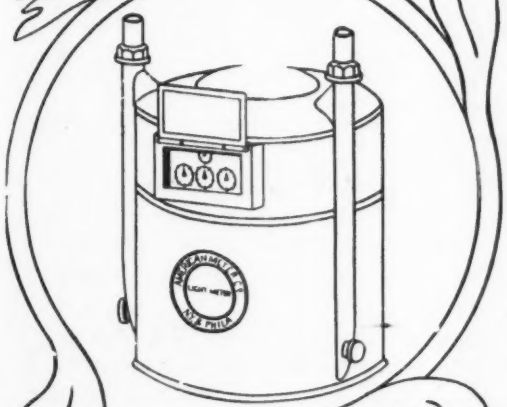
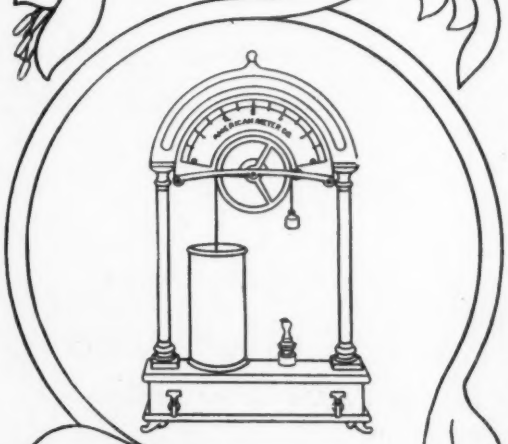
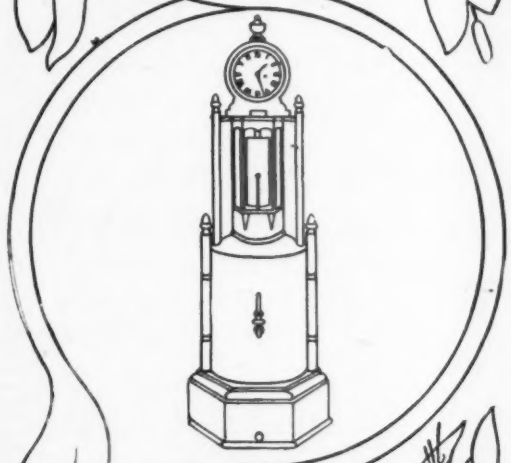
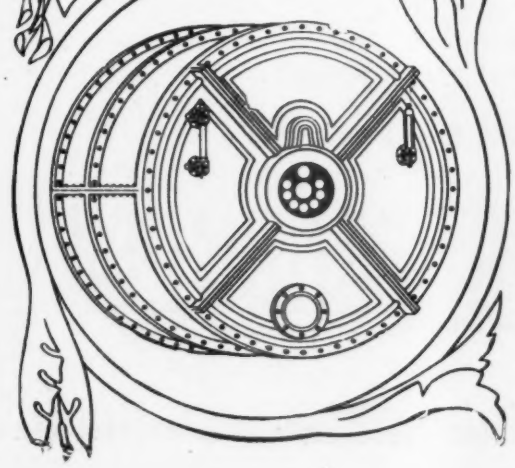




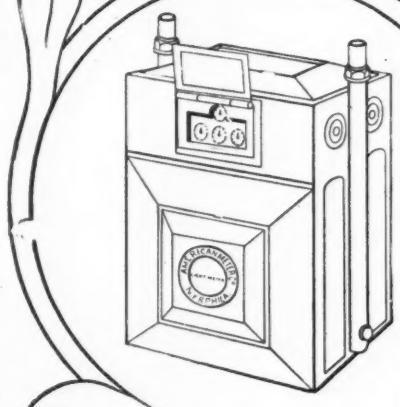


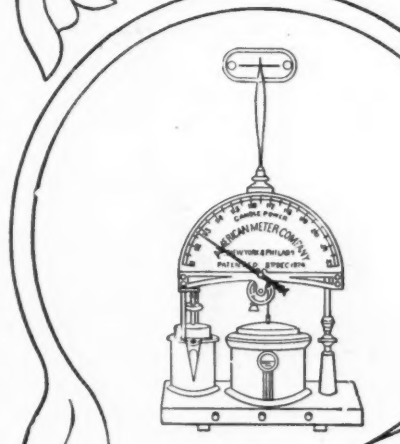


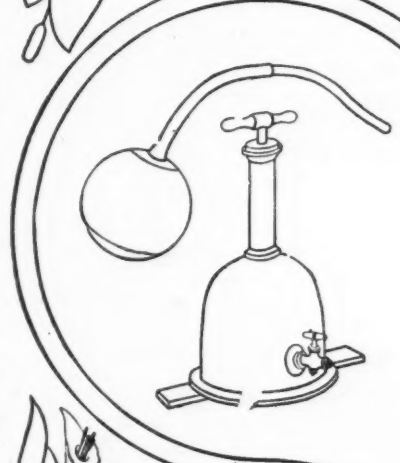
PUBLIC LIGHTING TABLE.

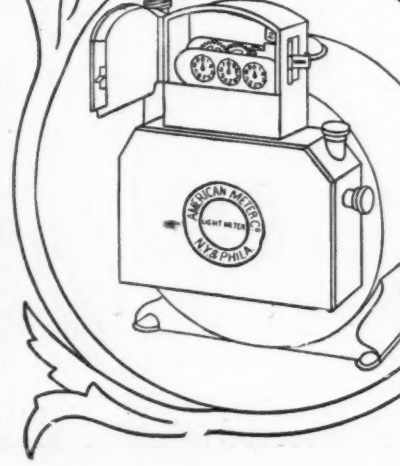
SEPTEMBER, 1903.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Tue.	1	12.30 AM	4.30 AM	6.30	4.20
Wed.	2	1.20	4.30	6.30	4.20
Thu.	3	2.10	4.30	6.15	4.30
Fri.	4	3.10	4.30	6.15	4.30
Sat.	5	No L.	No L.	6.15	4.30
Sun.	6	No L. FM	No L.	6.15	4.30
Mon.	7	No L.	No L.	6.15	4.30
Tue.	8	6.50 PM	8.10 PM	6.15	4.30
Wed.	9	6.50	8.40	6.15	4.30
Thu.	10	6.50	9.20	6.05	4.40
Fri.	11	6.50	10.00	6.05	4.40
Sat.	12	6.50	10.40	6.05	4.40
Sun.	13	6.40	11.30	6.05	4.40
Mon.	14	6.40 LQ	12.20 AM	6.05	4.40
Tue.	15	6.40	1.20	6 05	4.40
Wed.	16	6.40	2.30	6.05	4.40
Thu.	17	6.40	4.40	5.55	4.50
Fri.	18	6.40	4.40	5.55	4.50
Sat.	19	6.40	4.40	5.55	4.50
Sun.	20	6.30 NM	4.50	5.55	4 50
Mon.	21	6.30	4.50	5.55	4.50
Tue.	22	6.30	4.50	5.55	4.50
Wed.	23	6.30	4.50	5.55	4.50
Thu.	24	6.30	4.50	5.40	5.00
Fri.	25	8.00	4.50	5.40	5.00
Sat.	26	8.40	4.50	5.40	5.00
Sun.	27	9.30	4.50	5.40	5.00
Mon.	28	10.20 FQ	4.50	5.40	5.00
Tue.	29	11.10	4.50	5.40	5.00
Wed.	30	12.10 AM	4.50	5.40	5.00









TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45

No. 904 Welsbach Outdoor Arc

Furnished with 2, 3, 4 or 5 Burners

This Lamp is Built to Stand

rough usage and severe weather conditions. In mechanical construction and workmanship it is perfect.

The material is of the best. All exposed metal parts made of cold rolled sheet copper.

Guaranteed Positively

Rain=proof

Wind=proof

Insect=proof

The main cock lights one or all burners. Pilot flash light.

18-inch enameled steel reflector shade.

Long tube burners, with adjustable needle gas feed, permit use of either 3½-inch or 4½-inch mantles.

Renewal of Mantle

made easy and without danger of breakage by raising the body of the lamp on main stem. The neck of the globe thus acts as a wind guard, protecting the other mantles from damage by weather conditions.

Candle Power Test

of 4-burner lamp:

With 3½-inch mantles, 412-candle power.

With 4½-inch mantles, 503-candle power.

WELSBACH COMPANY,

GLOUCESTER, N. J. CHICAGO, ILL.

ORDERS ACCEPTED FOR SHIPMENT ON AND AFTER SEPTEMBER 15.

Sample Case of 3, 6 or 12 lamps sent on 30 days' approval at prices based on 100 lamps.

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For the Six Months Ending July 1, 1903, has been Awarded Contracts in the Following Places for

Standard Double-Superheater Lowe Water Gas Apparatus.

Rochester, N. Y.	Brooklyn, N. Y.	Waltham, Mass.
Baltimore, Md.	Hempstead, N. Y.	Dover, Del.
Chicago, Ills.	Chester, Pa.	Allentown, Pa.
Amesbury, Mass.	Lynn, Mass.	Savannah, Ga.
Aberdeen, S. D.	Newark, N. J.	New York (Central Union Co.)
Winsted, Conn.	Washington, D. C.	Cicero, Ills.
Canon City, Col.	Boone, Ia.	Chicago (Ogden Co.)
Schenectady, N. Y.	Pueblo, Col.	Easton, Pa.
Hagerstown, Md.	Charlotte, N. C.	Lawrence, Mass.
Malden, Mass.	Fall River, Mass.	Council Bluffs, Ia.
Bridgeport, Conn.	Duluth, Minn.	Chattanooga, Tenn.
Albert Lea, Minn.	New York (Mutual Co.)	

TOTAL SETS TO JULY 1, 1903, ... 51
TOTAL DAILY CAPACITY, ... 55,150,000 cubic feet.
TOTAL SETS TO DATE, ... 498
TOTAL DAILY CAPACITY, ... 354,830,000 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia

Established 1853. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

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FIRE BRICK and FIRE CLAY SPECIALTIES

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SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,

OFFICE AND WORKS:
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Established 1854. Incorporated 1869.

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Fire Brick Manufg. Co.,

Manufacturers of { GAS RETORTS . .
FIRE BRICK . . .
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Proprietors for the U. S., Coze System of Inclined Benches.

Estimates Furnished on Application for Most Successful Style of Construction.

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

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Established 1845. Reorganized 1902.

The Kreischer Brick Mfg. Co.,

Manufacturers of the very best quality of Clay Retorts, Blocks, Tiles, Settings and Firebrick of every description.

Also Miners and Shippers of Fireclay, Fire Sand, Ground Brick in Barrels.

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OFFICE: 119 E. 23D STREET, NEW YORK CITY.

Adam Weber Sons.

Works. Weber, N. J.
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Modern Recuperative Furnaces.

Standard Fire Brick and Gas Retorts.

OSCAR B. WEBER'S

Construction Vertical 8's (Patented).
First Instalment in the World with Modern Charging and Discharging Machinery.

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LEEDS ENGLAND,
INCLINED RETORT SYSTEM.

Perforated Radial Block Chimneys.

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Successor to WILLIAM GARDNER & SON.

Fire Clay Goods for Gas Works.

HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY
RETORT WORKS

WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,
BENCH SETTINGS,
Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. Galesburg, Ills., or Buffalo, N. Y.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

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For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

The Gas Engineer's Pocket-Book,

By HENRY O'CONNOR.

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RETORT & FIRE BRICK CO.

MANUFACTORY AT
LOCUST POINT, BALTIMORE, MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY,
AND FIRE CEMENT.

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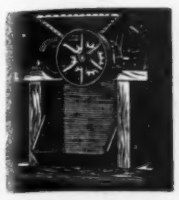

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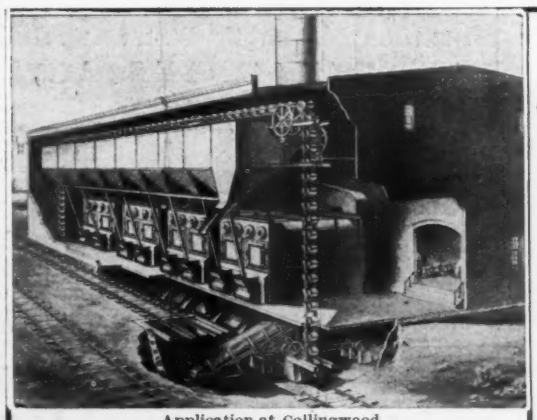

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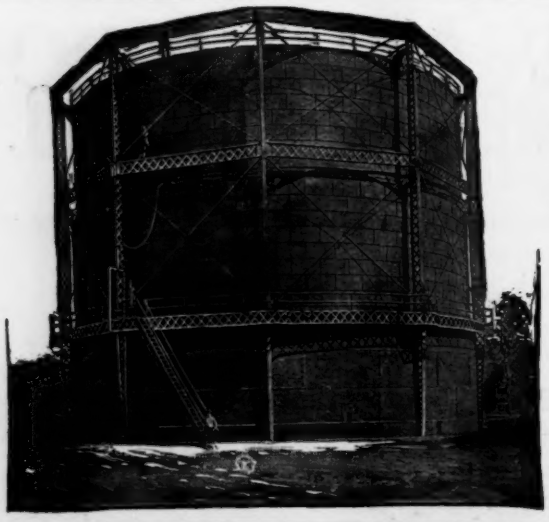

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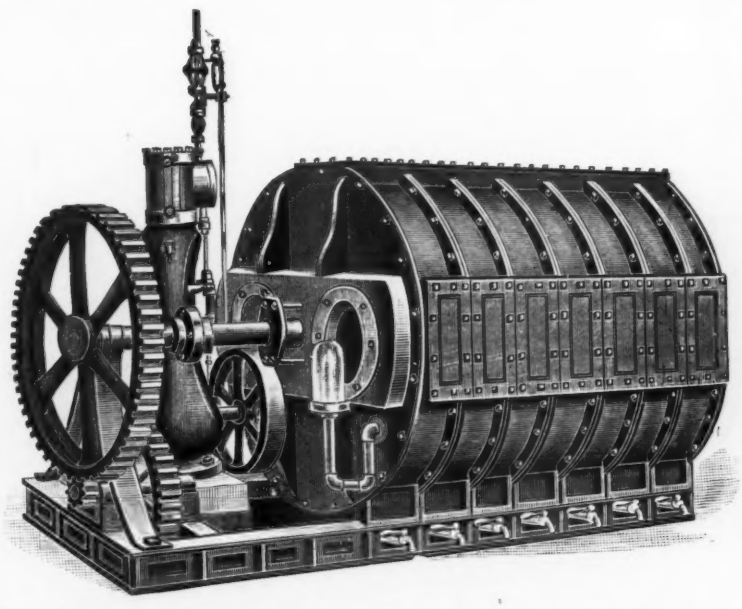

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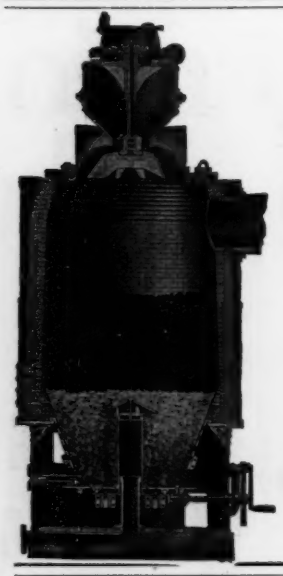

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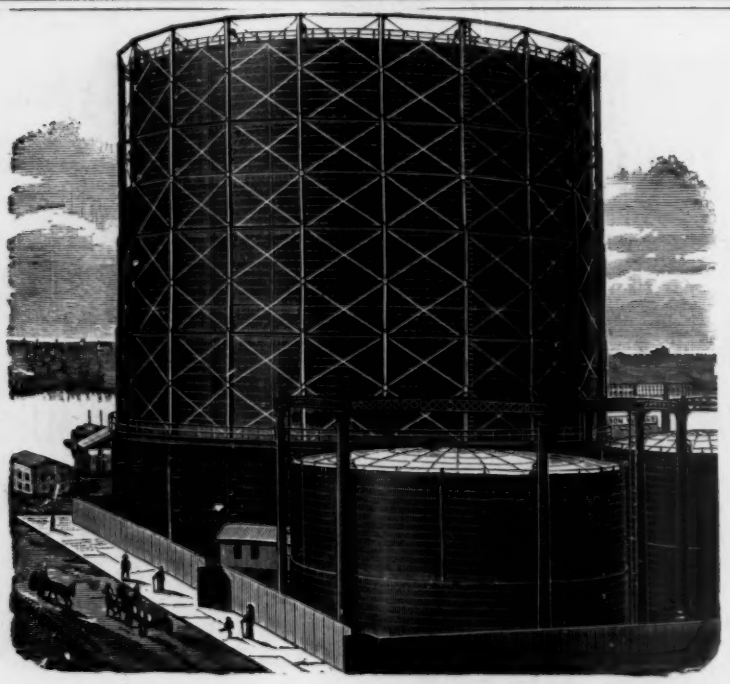

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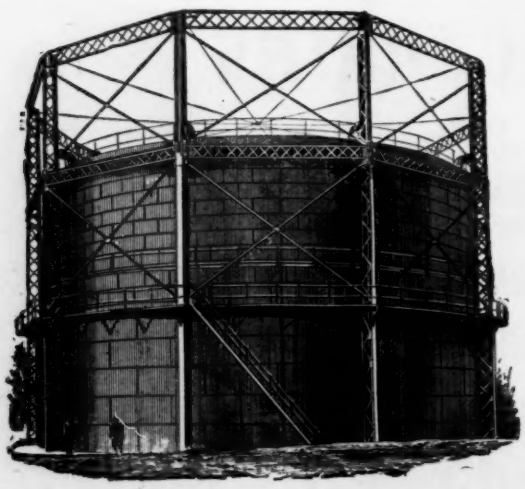

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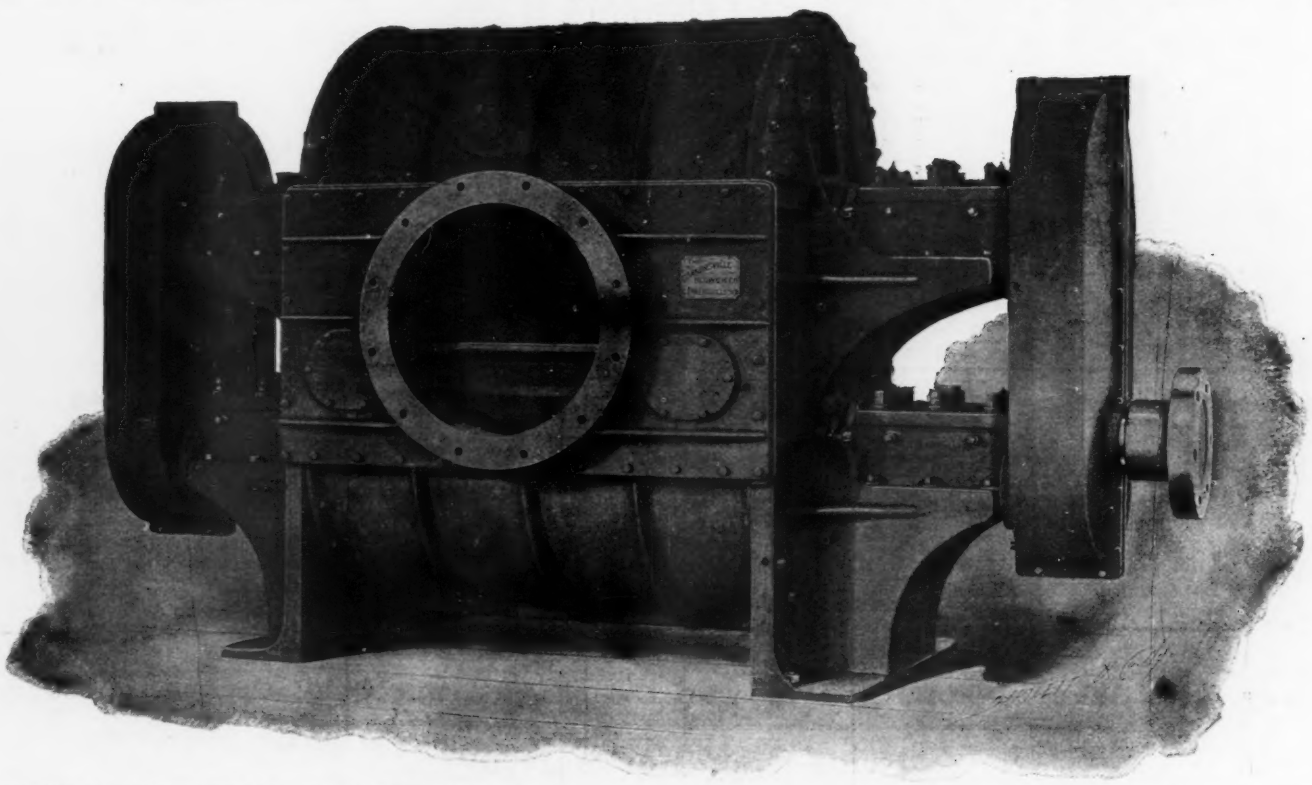

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